FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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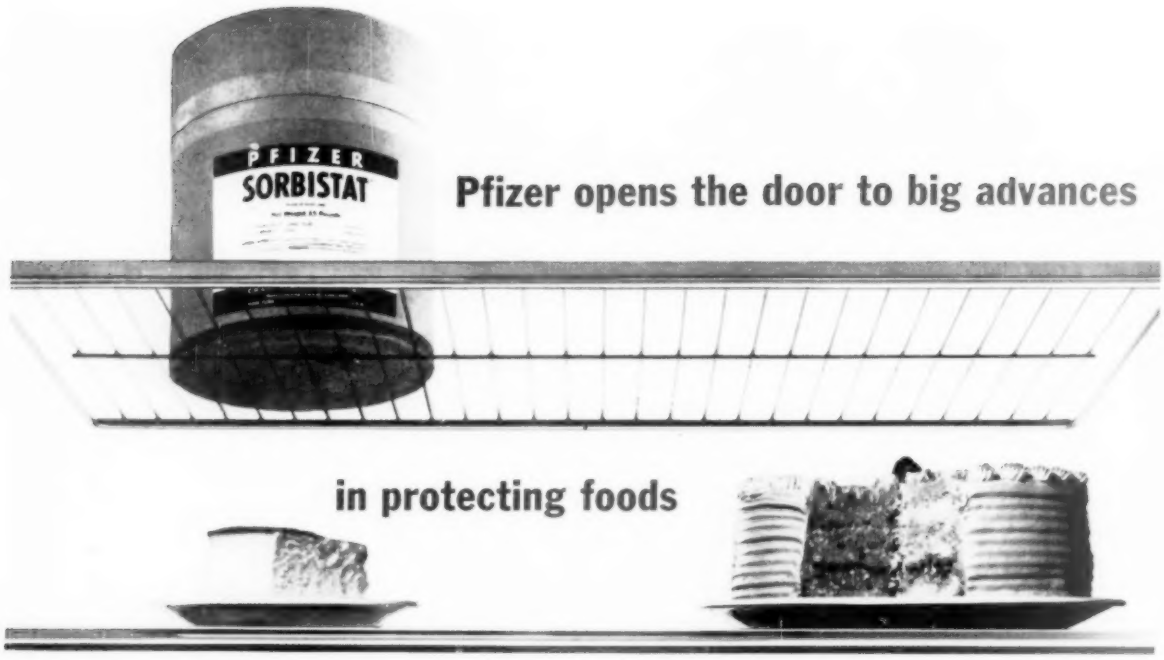

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against mold and yeast spoilage...

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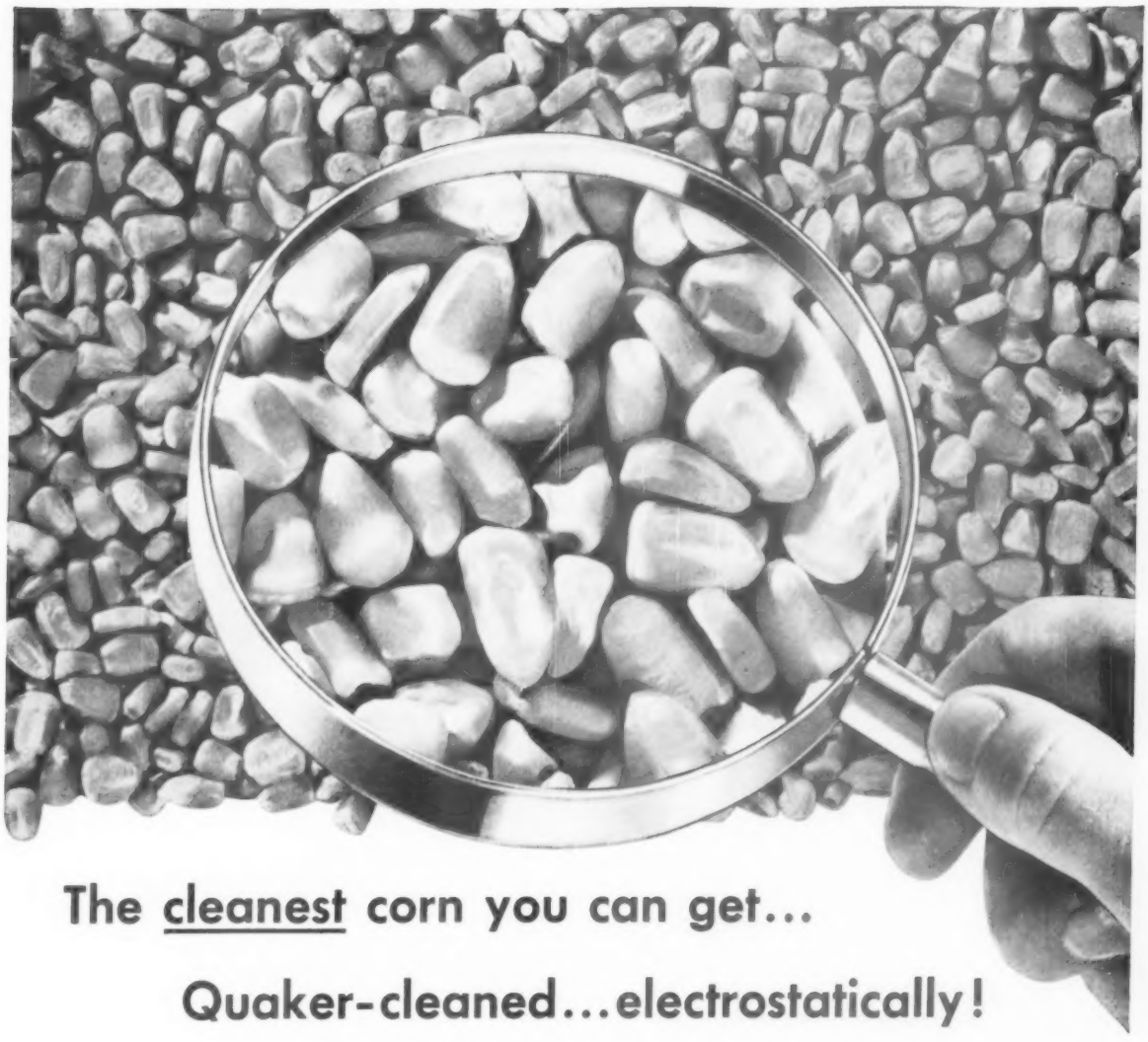

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Electrostatic cleaning operates on the ability of different particles to take on different degrees of an electrostatic charge. Other methods depend only on differences in size and weight of the materials to be separated. But because these materials carry varying degrees of electrostatic charge, Quaker's electrostatic cleaning also *removes* contamination of the *same size and weight* as the material being cleaned.

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IFT ACTIONS AND REACTIONS...

Policies, Rules and Regulations Governing Awards, Scholarships, And Fellowships Administered by the Institute of Food Technologists

The Council having delegated to its Executive Committee the authority and responsibility for the administration of Institute Awards, that Committee hereby announces the following policies, rules and regulations governing Awards.

1. POLICY ON AWARDS

It is the policy of the Institute to accept awards for administration provided they meet the conditions set forth below.

a. The award may be monetary or honorary.

b. The field in which the award is to be made must be broad and recognized as basically important so that an adequate number of qualified candidates will be assured throughout the life of the award.

c. Each award must be established for three or more years. Awards may be renewed for three or more years.

d. Acceptance of awards and approval of the rules and regulations governing awards must be made by the Executive Commitee.

e. Not more than one Institute of Food Technologists award shall be made to the same individual in one year unless specific provision therefor is made herein.

2. INSTITUTE AWARDS COMMITTEE

a. There shall be an Institute Awards Committee consisting of a Chairman, a Vice Chairman and the Chairmen of all Institute Award Juries.

b. The members of the Committee and Award Juries shall be appointed by the President except as otherwise provided herein.

c. The President shall have authority to fill any vacancies that may occur on the Committee or on any Award Jury.

d. The Vice Chairman shall be appointed annually by the President-Elect and shall serve until his successor has been appointed. Upon the appointment of a successor the Vice Chairman shall become Chairman.

3. DUTIES AND RESPONSIBILITIES

This Committee shall concern itself with matters of policy, establishing or changing operating procedures of Award Juries, the acceptance of New Awards and changing existing Awards and make recommendations to the Executive Committee on these matters.

The Chairman is responsible for general supervision of the activities of all Awards Juries and the Awards Publicity Commitee, to insure that deadlines are met in the selection of awardees and the issuance of publicity material. He shall, in collaboration with the President, make the arrangements for the Awards Luncheon including furnishing to the Editor the material for the printed Luncheon program.

4. AWARD JURIES

There shall be Juries to determine the recipients of the various awards. The Juries, their appointment and the rules under which they operate shall be as prescribed in the following paragraphs. The Executive Committee may, as need arises, establish other Juries. The identity of Institute Award Jurors shall be kept secret.

5. THE BABCOCK-HART AWARD

DONOR: The Nutrition Foundation.

AWARD: $1,000.00 from the donor, plus an engrossed Plaque furnished by the Institute.

PURPOSE: To honor a person who has distinguished himself or herself by contributions to Food Technology which have resulted in improved public health through some aspect of nutrition or more nutritious food.

JURY

CHAIRMAN: The most recent surviving Past President of the Institute. The Chairman shall have no vote in selecting the recipient.

JURORS: Nine Jurors who are members of the Institute of Food Technologists. Three new Jurors shall be appointed each year by the President at the time he is inaugurated. Appointments will be made in collaboration with the new Chairman of the Awards Committee and should provide for continuing wide diversity in both geographical location and field of professional interest. When new Jurors accept, the three who have had the longest tenure on the Jury will retire.

NOMINATIONS: Nominations may be made to the Chairman of the Jury by any member of the Institute of Food Technologists. Nominations shall be in letter form giving a biographical sketch and indicating the contributions that qualify the nominee for the award. Members of the Jury may and should make nominations. Nominating letters shall be limited to one, single-spaced, typewritten sheet.

GENERAL CONDITIONS: The Jury, in selecting a recipient, must be aware that The Nutrition Foundation is making similar awards to the Institute of Nutrition, American Dietetics Association, and the American

(Continued on page 4)

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(Continued from page 2)

Medical Association. This emphasizes the need for the Jury to differentiate sharply between the contributions in clinical nutrition and fundamental scientific studies in nutrition on the one hand, and technological developments which influence the nutritional well-being of the public on the other hand. This Award can be made only for technological developments or scientific contributions which lead directly to technological developments.

RULES OF PROCEDURE

The Chairman of the Jury shall place a notice calling for nominations in the November and December issues of FOOD TECHNOLOGY. (Copy for the notice shall be furnished to the Editor not later than September 15th.) January 15th shall be the deadline for receiving nominations.

An illustration of a contribution in the phase of processing might be the development of equipment that would process food in a way to conserve nutrients or to prevent wastage of the food. Another possibility of a contribution in food processing which would qualify for this Award would be the development of a process which would inhibit or prevent bacterial spoilage, oxidation, desiccation, or enzymatic deterioration of food, providing such contribution eventually influenced the nutritive well-being of the consumer. It is conceived that such contribution could be made in the field of food production, food processing, or food storage and distribution. In the field of food production, the contribution might result from genetic studies which would develop improved strains or cereals or fruit or vegetable, which would provide greater yield or increased nutritive content. Another contribution in the field of production might result from studies on animal nutrition which improve efficiency or production, or studies in animal diseases which result in decreased losses, etc. Contributions could be made in either packaging or storage or distribution conditions which would eventually affect the nutritive value and thus qualify for this Award. Better control in any one of these phases may exert an influence which would qualify for this Award. The distinctive criterion which would qualify for this Award would be that the contribution to science or technology should have been put into actual production on a large scale and actually resulted in an influence on better nutrition.

The Chairman of the Jury shall tabulate the names received as nominees, arranging the names in alphabetical order, and send a copy to each member of the Jury, asking that he vote for a first, a second, and a third choice. The ballots will be due not later than March 1. On receipt of the ballots, the Chairman of the Jury will weight all first choice 3 (three), all second choice 2 (two), all third choice 1 (one); totalling the ballots by this weight procedure he will select not more than the two receiving the highest total weighted vote, and form a ballot which will be sent not later than March 10 to each Juror, asking the Juror to express his choice between the two candidates. These final ballots being due back not later than March 20. The candidate receiving the majority vote of the Jury will be declared the recipient.

In case a Juror is nominated, he will be immediately notified and dropped from the Jury so long as his name is under consideration. If the name of the Juror is eliminated in the course of the voting, he shall then become eligible as a member on subsequent ballots. This shall not invalidate any nomination which may be made by said Juror.

Upon selection of an awardee, the Chairman of the Jury shall promptly notify the Chairman of the Awards Committee with a copy of his letter to the Executive Secretary of the Institute.

PRESENTATION

The presentation of the Award shall be made at the Awards Luncheon held during the Annual Meeting of the Institute. The donor will be invited to have a representative make the presentation. The details of the ceremony will be arranged by the Chairman of the Awards Committee in collaboration with the President of the Institute.

6. THE UNDERGRADUATE AND GRADUATE AWARDS JURY

CHAIRMAN: Appointed by the President (should preferably be selected by the President-Elect before he assumes the Presidency in order to avoid loss of time in transition. The selection shall be made in collaboration with the then Vice Chairman of the Awards Committee). He shall be a Professional Member of the Institute and preferably should have served on the Jury. The Chairman shall have no vote except to decide a tie, as provided herein.

JURORS: Six Jurors who are members of the Institute. Two shall be appointed each year by the President upon his inauguration. Appointments will be made in collaboration with the Chairman of the Awards Committee and the Chairman of this Jury. When new Jurors accept, the two who have had longest tenure on the Jury shall retire.

7. UNDERGRADUATE AND GRADUATE AWARDS

a. Florasynth Fellowship:

DONOR: Florasynth Laboratories, Inc.

AWARD: $1,000.00—For the academic year payable $100.00 per month for eight months and $200.00 the ninth month, and a Certificate furnished by the Institute.

PURPOSE: To encourage Undergraduate and Graduate work in the field of food science.

NOMINATIONS: Nominations for the fellowship shall be made by the Head of the Department who supervises the work of the Candidate. The nomination shall be in letter form and give the following information regarding the nominee:

Name and mailing address

Nationality

(Continued on page 6)

FOOD TECHNOLOGY

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Responsibility for statements appearing in FOOD TECHNOLOGY rests on the author thereof; points of view expressed in the columns of the journal do not necessarily have the endorsement of the Institute of Food Technologists. Mention of commercial products in the technical pages of this Journal is not to be construed as a recommendation of such products over others in the same category.

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176 West Adams Street, Chicago 3, Illinois

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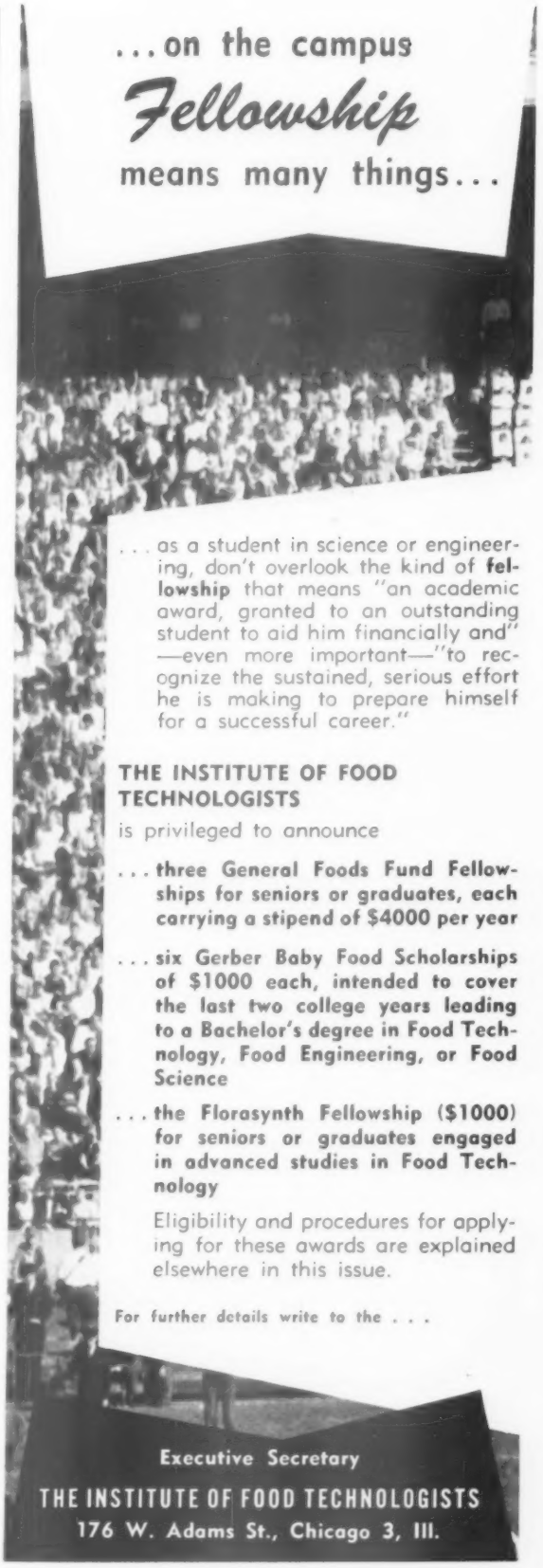
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Fellowship
means many things...
. . . as a student in science or engineering, don't overlook the kind of fellowship that means "an academic award, granted to an outstanding student to aid him financially and" —even more important—"to recognize the sustained, serious effort he is making to prepare himself for a successful career."
THE INSTITUTE OF FOOD TECHNOLOGISTS
is privileged to announce
. . . three General Foods Fund Fellowships for seniors or graduates, each carrying a stipend of $4000 per year
. . . six Gerber Baby Food Scholarships of $1000 each, intended to cover the last two college years leading to a Bachelor's degree in Food Technology, Food Engineering, or Food Science
. . . the Florasynth Fellowship ($1000) for seniors or graduates engaged in advanced studies in Food Technology
Eligibility and procedures for applying for these awards are explained elsewhere in this issue.
For further details write to the . . .
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(Continued from page 4)

Sex, age and marital status

A small photograph of the applicant

College or university academic record in transcript

Noteworthy scholastic or research accomplishments

Justification for proposing the candidate (in complete detail) including a statement as to the need, if any, for financial assistance.

A candidate must have a better than average scholastic record and/or a B.Sc. or equivalent, preferably with honor, from an institution of recognized standing.

Nominations, to arrive not later than February 1st, shall be sent to:

The Executive Secretary
Institute of Food Technologists
176 West Adams Street
Chicago 3, Illinois

GENERAL CONDITIONS: The fellowship will be granted annually to a young man or woman who is:

—a citizen of the U. S. or Canada under 35 years of age,

—a senior undergraduate or one engaged in graduate work for an advanced degree,

—at a recognized educational institution in the U. S. or Canada which is conducting fundamental investigations for the advancement of Food Technology,

—a person of outstanding qualities of character and personality, and a demonstrated scientific or engineering aptitude together with an above average interest in research.

The Award shall be made to a person in a different institution each year, except that after three years, the Award may again be made to a person in an institution where it was previously held.

RULES OF PROCEDURE

The Executive Secretary of the Institute shall make sufficient copies of the nominations, and send the original to the Chairman of the Undergraduate and Graduate Awards Jury and Verifax copies to the Jurors. The originals of all photostats, blue prints or other material that will not reproduce by Verifax shall be sent to the Chairman of the Jury who may prepare summaries of these and distribute or circulate the originals among the Jurors. The Secretary shall send a copy of his letter of transmittal to the Chairman and Vice Chairman of the Institute Awards Committee.

After distribution of the nominations and supporting material to the Jurors, the Chairman shall call for ballots. Each Juror shall take into consideration all supporting evidence presented in behalf of the candidates and shall list, in order of preference, the three candidates he considers to have the most deserving qualifications for the Fellowship.

The Chairman of the Jury, upon receipt of the ballots, shall ascertain which candidate has first rank of priority by composite selection and shall designate that person

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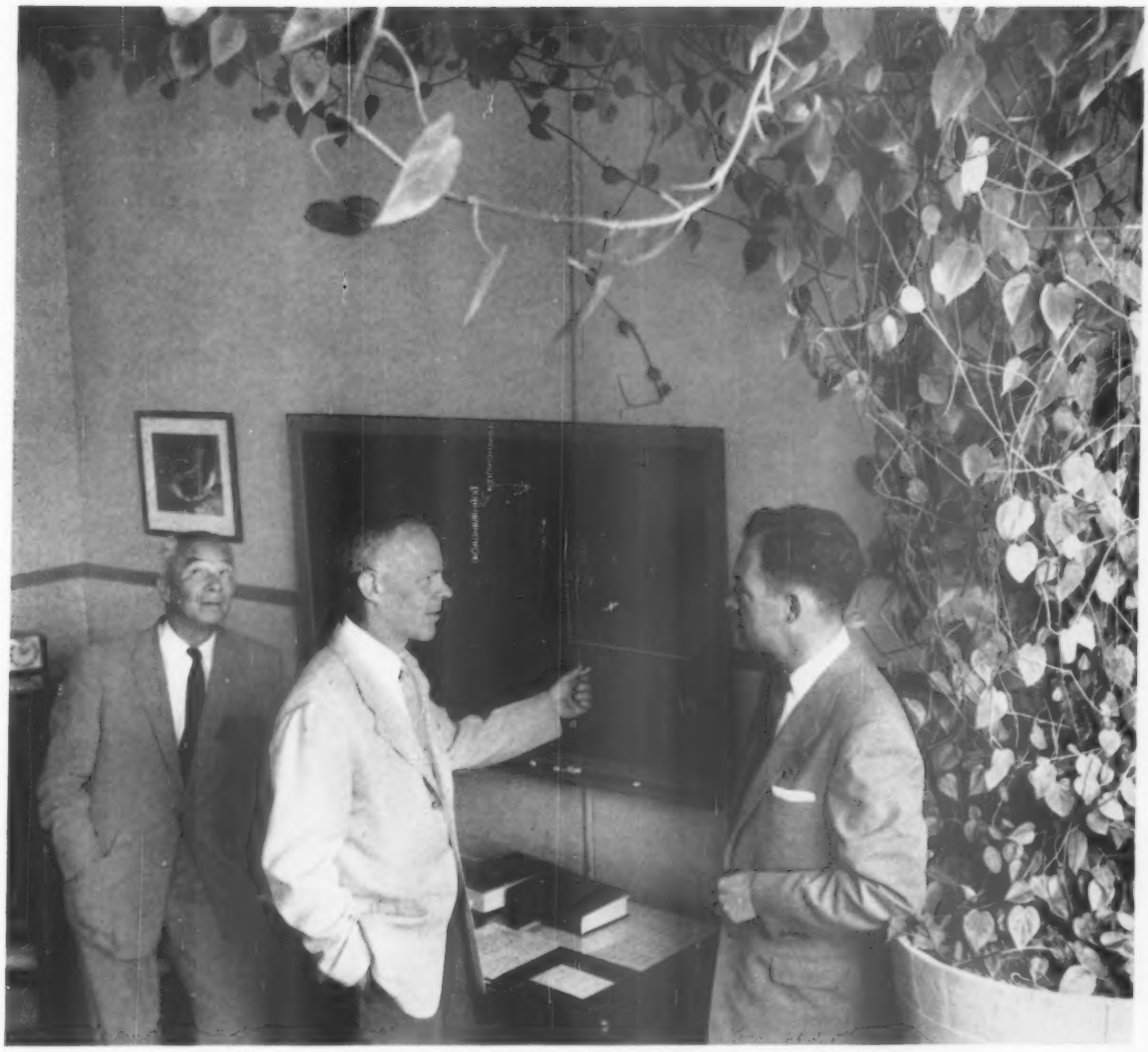

The **vitamins** and the philodendron

The man with the chalk is Dr. Norris Embree, our director of research. The other two are a customer's technical staffers, running down rumors of new vitamin A derivatives. The vegetation is a philodendron.

The philodendron comes under the jurisdiction of the Landscaping Division, Yard Department, Kodak Park Works, who feel that they have not been taken rightfully into confidence and have been miffed for a decade. They suspect that Doctor Embree usurps their prerogatives by feeding the monster something probably related to vitamin A. Else what would be the point?

Dr. Embree never talks about the jungle that crowds him, which adds to its aura of significance. While visitors sneak glances at the cryptic greenery, he holds forth instead with new viewpoints and facts about vitamin A in a manner to fascinate and inspire margarine manufacturers who happen to want to know something about the vitamin other than delivery dates and packaging.

Our business is producing Myvax® Vitamin A in bulk put up in batch-sized cans as Myvapack® Vitamin A. Also to have it available for immediate shipment from stock. For information, a quotation, or an appointment to see Doctor Embree's philodendron, write ***Distillation Products Industries,*** Rochester 3, N.Y. Sales offices: New York, Chicago, and Memphis • W. M. Gillies and Company, Los Angeles, Portland, and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

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(Continued from page 6)

as the awardee. Should the balloting at this point result in a tie, the Chairman will resubmit the names of the two persons in first priority rank to the Jurors and request them to vote for one candidate for first priority and the candidate receiving a simple majority shall be the Awardee. Should a tie result at this point, the Chairman shall cast the deciding vote.

Upon selection of an awardee, the Chairman of the Jury shall promptly notify the Chairman of the Awards Committee with a copy of his letter to the Executive Secretary of the Institute.

PRESENTATION

The Winner shall be announced by the President at the Annual Meeting. The announcement may be at either the General Session or the Awards Luncheon. The presentation of the Award Certificate shall be made at a regular or special meeting of the Section in the area where the educational institution attended by the recipient is located. Should that not be possible, the Award Certificate shall be mailed to the Head of the Department in which the recipient is conducting his work, with a request that the Head make the presentation on behalf of the Institute of Food Technologists. When the presentation is to be made at a Section Meeting, the donor will be notified of the time and place and invited to have a representative make the actual presentation. The Executive Secretary shall be responsible for arranging the presentation.

REPORTS

The fellow may be required to furnish to the Institute, at the discretion of the Awards Committee, brief written interim reports in duplicate, on the progress of his investigations under the Fellowship. A final report in the form of a detailed report, thesis or published paper in duplicate will be required from each fellow.

b. General Foods Fellowships:

DONOR: The General Foods Fund, Inc.

AWARD: Three fellowships at $4,000.00 each and a Certificate furnished by the Institute. The fellowships shall be for a full calendar year. The Fellow shall receive a minimum of $200.00 per month for 12 months, the remaining $1,600.00 to be used as follows: (a) pay all academic fees of the fellow; (b) any remaining moneys will accrue to the department fund of the department wherein the Fellow is working, to be used at the discretion of the Department Head. This portion of the Award may be used for direct research expense including travel by the fellow. If the Department Head so elects, all or a portion may be used to increase the payments to the fellow. Disposition of this portion of the Award shall be determined by conference between the Department Head, the Fellow and the Executive Secretary of the Institute of Food Technologists.

The fellowships will be granted anually—no more than two to the same educational institution for the same calendar year, but will be renewable upon application to and approval by the Awards Jury for a maximum of three years, in order to provide for continuity of studies leading to a doctorate degree, if the candidate so plans. However, candidates, who plan only a year of research after obtaining the Bachelor Degree, or who plan to study for a Master's Degree, will not be excluded.

The awards will be made to deserving and outstanding United States or Canadian citizens, engaged in senior undergraduate or graduate work in recognized educational or research institutions in the United States of America or Canada, in basic or applied chemistry, chemical engineering or related sciences, which may involve new physical or other procedures, directed to extending or improving knowledge in some phase of food conservation, food production or food processing, rather than primarily for research in the fields of nutrition, bacteriology or analytical chemistry.

In order to qualify, an applicant must be a senior undergraduate student, with better than average scholastic record at an institution of recognized standing; or, a graduate student with a B.Sc. or equivalent, preferably with honors, from an institution of recognized standing.

PURPOSE: To encourage graduate work in the field of food science.

APPLICATIONS: Applications must be sent to the Executive Secretary of the Institute to arrive not later than February 1 and shall be in letter form, giving the following essential personal and academic information with respect to the applicant:

—Name, nationality, sex, age, marital status, physician's statement with respect to the general health and physical condition of applicant.

—Educational and experience background, transcript of college or university academic records, list of noteworthy accomplishments in research and the purpose of applicant in applying for the Fellowship.

—A small photograph of the applicant.

The applicant shall have an approved plan of research in Food Technology and acceptance thereof by the Graduate School of the institution in which he proposes to hold the Fellowship.

In presenting his application, the applicant should indicate his definite intention on his word as a gentleman, to carry through with his approved research plan for the period of time for which the award is made insofar as it is humanly possible.

Three letters of recommendation must be forwarded separately to the Office of the Secretary of the Institute by Deans, Heads of Department and/or Professors, who have supervised academic work of the applicant. These letters should present essential facts regarding the scholarship record, character and personality, ability to cooperate and capacity for work and achievement, of the applicant.

Each application shall be accompanied by a letter from the Head of the Department where the applicant proposes to do his work, accepting for the school re-

(Continued on page 10)

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Vanilla Bean Flavor by Firmenich stems from the vanilla bean. By original research, its components and desirable characteristics have been isolated, identified, and synthesized. By patient and painstaking laboratory techniques, they have been reconstructed for you in a precise and potent flavor material with all the aromatic qualities of the original. Vanilla Bean Flavor by Firmenich comes to you as an economical replacement of pure vanilla extract, of pure vanillin, or to use in combination in the manufacture of all products that you flavor with this most popular of flavors. Contains no coumarin.

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GENEVA PARIS LONDON

(Continued from page 8)

sponsibility connected with the fellowship and stating that the Fellow is acceptable to his department.

RULES OF PROCEDURE

The Executive Secretary shall send the originals of all applications to the Chairman of the Undergraduate and Graduate Awards Jury and Verifax copies to all Jurors. Photostats, blue prints or other material that cannot be reproduced will be summarized by the Chairman and sent to Jurors or the originals may be circulated to the Jurors. Upon receipt of the applications and supporting statements, each Juror shall select the six highest ranking candidates and list them from one (1) to six (6) in the order of their standing. These selections shall be forwarded promptly to the Chairman of the Jury. The Chairman shall tabulate the composite ratings and shall drop all but the top 2, 4 or 6 candidates, depending upon whether 1, 2 or 3 awardees are to be selected. A subsequent ballot by priority rating shall then designate the highest one (1), two (2) or three (3) candidates as the successful ones. In case of a tie on the second ballot, the Chairman of the Jury shall cast the deciding vote. The Chairman of the Jury, after canvassing the ballots, shall immediately send lists of those to whom extensions have been granted and the winners of new fellowships to the Chariman of the Awards Committee with copies to the Executive Secretary of the Institute.

When 2 or 3 Fellowships are available after extensions, there shall be automatic disqualification of the lower ranking candidates in instances where more than two applicants from the same institutions for the same Fellowship have such ranking as to indicate that they might both be in the list of successful candidates.

Applications for extension of a Fellowship shall receive separate and prior consideration before proceeding as outlined above, since that action will determine the number of new Fellowships available for any given year. Applications for continuation must be accompanied by a letter from the Head of the Department recommending a continuation of the Fellowship.

The Fellow may be required to furnish to the Institute, at the discretion of the Committee on Awards, brief written interim reports, in duplicate, on the progress of his investigations, under the Fellowship Award.

A final report, in the form of a detailed report, thesis or published paper in duplicate will be required from each Fellow.

PRESENTATION

The Winners shall be announced by the President at the Annual Meeting. The announcement may be at either the General Session or the Awards Luncheon. The presentation of the Award Certificate shall be made at a regular or special meeting of the Section in the area where the educational institution attended by the recipient is located. Should that not be possible, the Award Certificate shall be mailed to the Head of the Department in which the recipient is conducting his work, with a request that the Head make the presentation on behalf of the Institute of Food Technologists. When the presentation is to be made at a Section Meeting, the donor will be notified of the time and place and invited to have a representative make the actual presentation. The Executive Secretary shall be responsible for arranging the presentation.

c. Gerber Baby Foods Scholarships:

DONOR: The Gerber Bay Foods Fund, Inc.

AWARD: Six (6) Undergraduate Scholarships at $1,000.00 each, per year. The Scholarships shall be for one school year of nine months. The student shall receive $100.00 per month for nine (9) months and the additional $100.00 shall be payable to the student at his election any time during the school year. The awards are intended to cover the last two school years leading to a Bachelor's Degree in Food Technology, Food Engineering or Food Science. The awards shall be made to deserving and outstanding United States or Canadian citizens of at least second year standing in recognized educational institutions in the United States or Canada. Not more than two of these scholarships may be held in the same school at the same time, except under unusual circumstances.

The curriculum of the Department wherein the scholarship is to be held must be approved by the Donor. These scholarships will be continued for the second year only upon satisfactory performance by the student and recommendation of the Department head wherein the scholarship is held.

Applicants to qualify must have completed (1) two full years of college mathematics, (2) two full years of chemistry, (3) one full year of physics, (4) one full year of biological sciences, (5) at least one year of the humanities.

Candidates will be judged on over-all ability including scholarship, personality, extra curricular activities, social adjustment, character, etc.

PURPOSE: To encourage deserving and outstanding students to take undergraduate work leading to a Bachelor's Degree in Food Technology, Food Engineering or Food Science.

APPLICATIONS: Applications shall be in the form of a letter from the applicant, giving the following personal and academic information:

—Name, nationality, age, sex, marital status, and a physician's statement as to the general health and physical condition of applicant.

—A transcript of all college or university work already completed.

—A small photograph of the applicant.

—A list of extra curricular activities.

The Head of the Department wherein the student is to hold the scholarship must write a supporting letter direct to the Executive Secretary of the Institute of Food Technologists giving the following information:

A general appraisal of the applicant with particular reference to the detailed requirements listed above.

A statement that the student will be accepted in his Department.

(Continued on page 12)

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(Continued from page 10)

8. INSTITUTE OF FOOD TECHNOLOGISTS INTERNATIONAL AWARD

DONOR: The Australian Regional Sections of the Institute.

AWARD: A suitably engraved Silver Salver.

PURPOSE: To promote the international exchange of ideas in the field of Food Technology. The Award shall be made annually to a member of the Institute of Food Technologists who has made outstanding efforts to promote the international exchange of ideas in the field of Food Technology or whose work has led to such exchange of ideas or to better international understanding in this field.

JURY

CHAIRMAN: The Chairman shall be appointed annually by the President and may succeed himself. Whenever possible, the Chairman shall be a person who has served on the Jury.

JURORS: There shall be six Jurors, two of whom shall be Australians or at least one other member shall be from other than the United States or Australia.

NOMINATIONS: Nominations shall be made by the Jurors.

RULES OF PROCEDURE

The Chairman of the Jury shall tabulate the names received as nominees, arranging the names in alphabetical order, and send a copy to each member of the Jury, asking that he vote for a first, a second, and a third choice. The ballots will be due not later than March 1. On receipt of the ballots, the Chairman of the Jury will weight all first choice 3 (three), all second choice 2 (two), all third choice 1 (one); totalling the ballots by this weight procedure he will select not more than the two receiving the highest total weighted vote, and form a ballot which will be sent not later than March 1 to each Juror, asking the Juror to express his choice between the two candidates. These final ballots being due back not later than March 20. The candidate receiving the majority vote of the Jury will be declared the recipient.

In case a Juror is nominated, he will be immediately notified and dropped from the Jury so long as his name is under consideration. If the name of the Juror is eliminated in the course of the voting, he shall then become eligible as a member on subsequent ballots. This shall not invalidate any nomination which may be made by said Juror. All correspondence with overseas members will be carried on by air mail.

Upon selection of an awardee, the Chairman of the Jury shall promptly notify the Chairman of the Awards Committee with a copy of his letter to the Executive Secretary of the Institute.

PRESENTATION

This Award shall be presented at the Awards Luncheon held during the Annual Meeting of the Institute. The Chairman shall be responsible for the details of the presentation as provided in Paragraph 5 supra.

Request for Information from Institutions Offering Food Technology Courses

In order to build up an adequate stock of information on food technology and related courses being offered by schools, colleges, and universities, at home or abroad, the IFT Committee on Education urges that heads of departments (or others) in institutions offering such courses get in contact with:

Dr. Walter A. Maclinn
Chairman, IFT Committee on Education
Department of Food Technology
Rutgers University
New Brunswick, New Jersey

First desire of the Committee is to obtain a complete roster of institutions offering courses in food technology or related subjects.

FIRST CALL FOR NOMINATIONS FOR BABCOCK-HART AWARD

In accordance with the Council's recent revision of the Rules and Regulations governing the Babcock-Hart Award, nominations may now be made by members of the Institute as well as by members of the Jury. Nominations should be in the form of a one page, single spaced, typewritten letter giving a biographical sketch and qualifications of the individual recommended for the Award. Such letters should be sent to Dr. L. E. Clifcorn, Chairman — Babcock-Hart Award Jury — American Can Company, Research Division, Barrington, Illinois. They must be received by January 15, 1957.

ELECTION RETURNS

Results of the voting on the Constitutional Amendments as listed below have been submitted by the official ballot counters (J. M. Blair, R. S. Bryant, L. W. Horne, D. A. Huber). Twelve hundred ballots were received; none was disqualified. The score:

	For	*Against*	*No Vote Cast*
ARTICLE VII			
Section 1	1,183	14	3
Section 2 (a)	1,183	14	3
Section 2 (b)	1,180	17	3
Section 2A	1,162	19	19
ARTICLE XI	1,184	14	2
ARTICLE XII			
Section 3	1,169	27	4

CANADIAN VISITORS, ATTENTION . . .

IFT members who expect to be visiting in Montreal, Toronto, Winnipeg or Vancouver, during the coming months, are urged to get in touch with Mr. Ben Berck, Canadian Department of Agriculture, Stored Product Laboratories, 724 Dominion Public Building, Winnipeg 1, Manitoba, Canada. Mr. Berck is desirous of lining up some IFT representatives for speeches before the Canadian Food Technology Association Sections in the cities mentioned.

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ANNUAL MEETING ANNOUNCEMENTS . . .

PITTSBURGH, CITY OF THE RENAISSANCE, TO BE SITE OF SEVENTEENTH ANNUAL MEETING OF IFT

FOOD TECHNOLOGISTS assembling in Pittsburgh in May 1957 may or may not be aware of the eventful years that have preceded the modern city of Pittsburgh. For more than two centuries the headquarters of the Ohio River have held a magic lure for men bent on discovery and fortune. An alert young surveyor, one George Washington, was first to recognize the value of the site. Here on a mission for the colonial Governor of Virginia in November, 1753, Washington reported that the point of land where the Allegheny, Monongahela and Ohio Rivers meet, was ideally situated for a fort. "It has absolute command of the rivers," Washington recorded in his diary, and he pressed the point in his report to the Governor.

On Washington's advice, a small company of troops was sent to build a fort at the Point, but this move appears to have been a bit premature. The troops were driven off by the French. The French, too, were aware of the imposing command of the rivers afforded by this point of land, and they promptly erected Fort Duquesne. The British made three attempts to recapture the area. In 1758, under General John Forbes, they finally succeeded in destroying the French bastion and in building Fort Pitt. General Forbes gave the Point the name,

The Block House (Fort Pitt)

"Pittsburgh," in honor of the English statesman, William Pitt.

Across the tortuous mountain trails and down the rivers soon came the frontiersmen and Pittsburgh became the springboard for exploration into the heartland of America. Pittsburgh, like many another "jumping off place," furnished a golden opportunity for young businessmen and manufacturers. As the Gateway to the West, it was the logical place for pioneers heading west to obtain their provisions and wagon gear. Pittsburgh was soon thriving. From the forests came the furs for clothing, the lumber for a thriving shipbuilding industry; from the rivers, sand for a glass industry;

Point at Present—Downtown Pittsburgh. Where the Allegheny and Monongahela Rivers meet the Ohio River.

from under the soil, coal and limestone and other minerals which helped to make Pittsburgh the world's greatest iron and steel producer and a manufacturing center for 5600 different products.

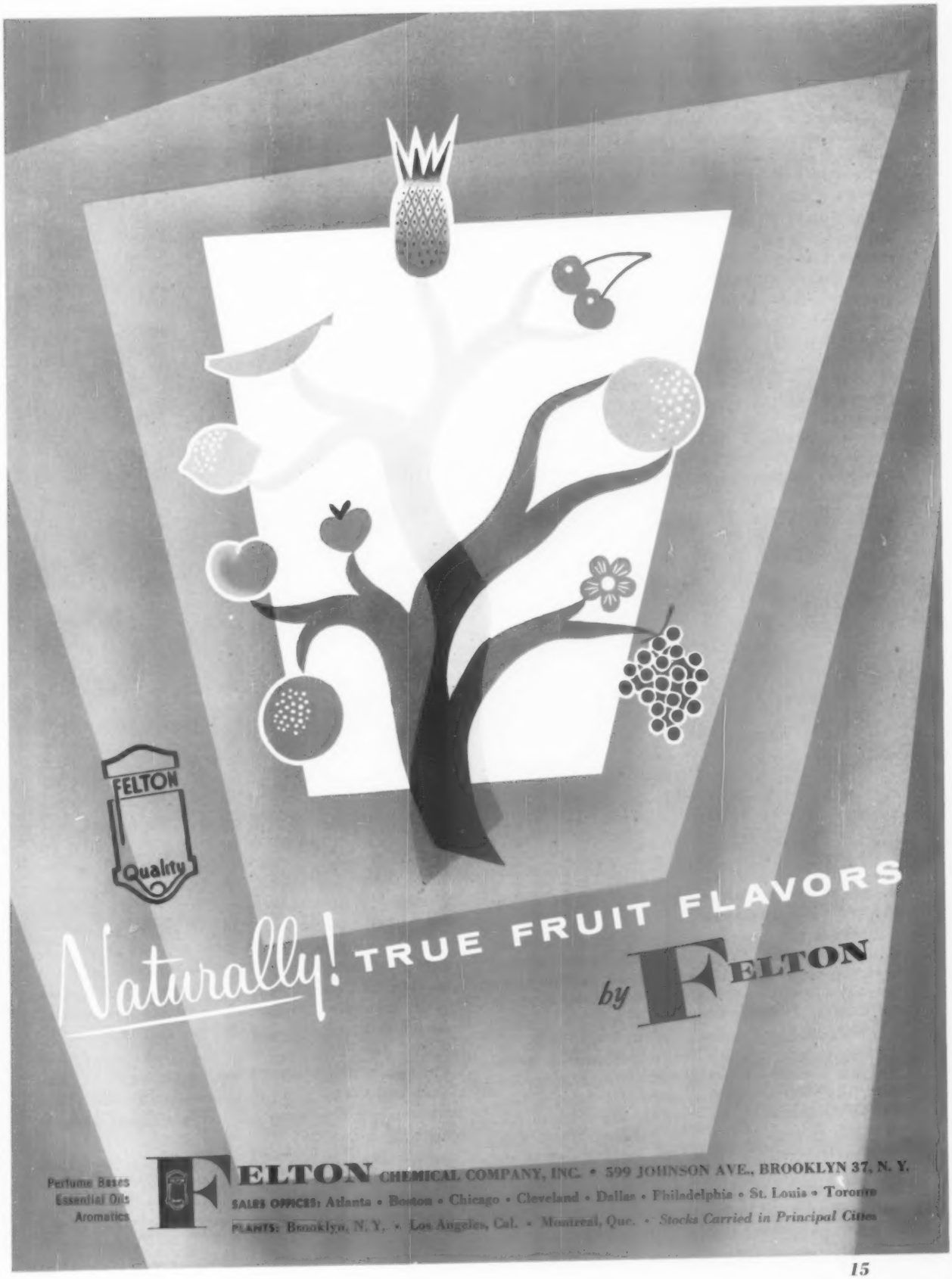
Pittsburgh today. Today, the industries command the river fronts. At the headwaters of the Ohio, the Block House—the last vestige of Fort Pitt—has been surrounded by a city of modern skyscrapers and retail shops, new highways and parks. Six million persons look upon the city as the hub of their trade and commerce. Within 500 miles lies half of America's population, two-thirds of its income, and three-fourths of its products.

Coal and three mighty rivers—the Ohio, Monongahela and Allegheny—have been Pittsburgh's greatest benefactors. They are the anvil on which was forged the world's greatest iron and steel producing center. But they created some problems. Exploited and unshackled, these two resources rebelled against the people they served and became the biggest obstacles to progress. Soft coal burned to a dense smoke that hung in the valleys like a black shroud. Deeper in the valleys, the rivers periodically unleashed their fury.

On March 17, 1936, the streams outdid themselves. Lowlands were submerged in as much as 30 feet of water. Thirty-six persons died in the disaster and estimates of property damage in the area ranged between 95 million and 125 million dollars.

Aroused Pittsburghers prevailed on the Federal Government to construct eight major flood control

(Continued on page 16)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(Continued from page 14)

reservoirs. There has been no repetition of the 1936 chaos.

Two hard-hitting ordinances, one by the city and one by Allegheny County, now regulate the density of smoke. Use of smokeless fuel is mandatory. Virtually all industry has installed mechanical filtering devices. The sun shines again. The streams are harnessed.

The Pittsburgh spirit. The brightest chapters of history have come when man has done more than struggle to exist . . . when he has looked toward the sky and envisioned a permanent legacy for his descendants.

It is buildings—whether pyramids, cathedrals, or skyscrapers—which most often emerge from such dreams. So it is in terms of buildings downtown that the review of Pittsburgh's redevelopment is most familiar.

No city has tackled a task with more energy. It organized a vendetta directed at decay. Year by year, decay had not only eroded the physical structure but also had destroyed initiative for self-improvement. Pittsburgh's campaign was a purge of blight that has resulted in the reconstruction of nearly a fourth of the 315 acres in the central business district of the city.

In a quarter century not a single new structure had been added. Yet in less than a decade, 51 new buildings have appeared and 4,000 off-street parking spaces created.

The control of smoke and floods has triggered a chain of benefits.

As a result of the smoke abatement efforts to date, Pittsburgh in the last five years has had 65% more sunshine, according to reports of the United States Weather Bureau. Of the many improvements, this new brightness brings the most frequent comments from visitors.

Conquests over floods and smoke have spurred a new spirit—one that perpetuates change rather than accepts the seemingly inevitable—and this has been translated into action with the demolition of scores of buildings for new facilities in the downtown area.

Perhaps the most dramatic evidence is the Point. Here, about six years ago, the State Department of Forests and Waters began spending $7,000,000 for the 36 acre Point Park project.

Equitable Life Insurance Company has erected three skyscrapers on the site which has been named Gateway Center, symbolic of Pittsburgh's historic position as the Gateway to the West. Three more skyscrapers are in the planning construction stage.

Uptown, almost simultaneously, have risen two other skyscrapers which assure Pittsburgh's position as the steel and aluminum capital of the world. The new 31-story Aluminum Company of America building is faced entirely in aluminum, an arresting departure in construction. A block away is the new United States Steel-Mellon skyscraper which towers 41 stories above the ground.

Between the two buildings an acre of business properties was leveled for Mellon Square Park and a six level underground parking garage. The midtown park was made possible by a $4,000,000 gift from various Mellon foundations.

In concept, design and natural beauty, the acre of greenery between Smithfield St., Oliver and Sixth Avenues, and William Penn Place, has no peer in the nation. And while it almost defies description, the square fulfills a necessary and more prosaic need—a parking area in the congested core of the central business district. Under its majestic surface, 1800 automobiles a day stream in and out of the six levels.

Thus, with this mixture of the aesthetic and practicality, Mellon Square achieves in one bold stroke three objectives: air and sunlight; easing of the parking shortage; and inspiration for rehabilitating an area and increasing its commercial value nearly ten-fold.

Mellon Square

Many of the delegates to the Institute of Food Technologists will arrive by air and they will find that the new Pittsburgh air terminal is a monument to vision. It is a sea of glass, marble and concrete; and it contains about every conceivable convenience, including a 62-room hotel, a motion picture theater and a night club.

Nowhere in the world is there a larger airport terminal. It stretches longer than three football fields and is seven stories tall. Even at that, designers allowed for future expansion. The future came very soon—a new wing is being added to provide more loading docks.

The airport has become a "showpiece" for visitors who admire the beauty of Canadian black granite, Missouri buff marble, and the acres of green grass. They are awed by a fountain 500 feet long, shimmering at night like a rainbow.

In a day when airliners are becoming bigger and faster, and flights are more frequent, there is only one course—to build an airport of the future. And Pittsburgh is determined to keep one step ahead of the future.

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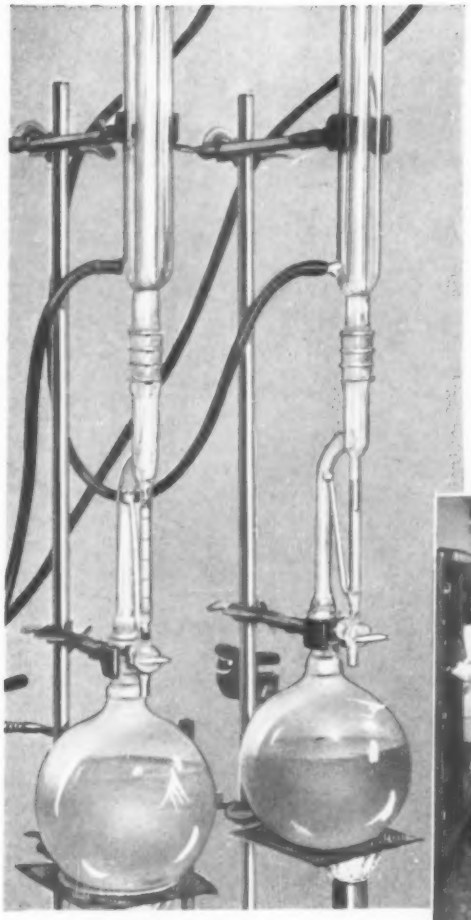

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IFT REGIONAL SECTIONS . . .

SPEECHES, SPECIAL EVENTS, NEWS NOTES

SOUTHERN CALIFORNIA . . . .

Dr. Charles Glen King—Executive Director, The Nutrition Foundation, Inc., 99 Park Avenue New York 16, New York

The program for the symposium on "Nutritives in Food and Food in Nutrition" has just been released by the Southern California Section of the Institute of Food Technologists. Co-sponsored by the Nutrition Foundation, Inc., it is to be held November 9 at the Huntington Sheraton Hotel in Pasadena, Calif. Because of the exceptional caliber of the speakers, it undoubtedly will be one of the finest meetings in the field of nutrition to be held this year.

PROGRAM

Co-Chairmen: Willard E. Baier, Roger W. Truesdail

Morning Session: Analytical Techniques

Kenneth Morgareidge (Chief Chemist, Food Research Laboratories, Inc.)—"The Expanding Function of Independent Laboratories in the Food Industry."

R. A. Bernhard (Western Utilization Research Branch, Fruit and Vegetable Chemistry Laboratory, Pasadena, Calif.)—"Chromatography: A New Dimension in Analysis."

Luncheon: Dr. Lee Du Bridge (President, California Institute of Technology).

Afternoon Session: Aspects of Nutrition

Wendell H. Griffith (Chairman, Dept. of Physiological Chemistry, University of California, Los Angeles)—"Dietary Factors Concerned with Fat Nutrition."

George W. Beadle (Chairman, Division of Biology, Calif. Institute of Technology)—"Genetic Guides in Searching for Chemical Characteristics."

Charles Glen King (Executive Director, Nutrition Foundation, Inc.)—"Major Problems in Nutrition Research and Education."

Dinner: Paul S. Armstrong (General Manager, Sunkist Growers, Inc.)—"What People Expect of Food."

Certificate of Achievement to Walter A. Knott. Walter A. Knott, founder of Knott's Berry Farm located in Buena Park, California, was presented with a Certificate of Achievement in the Food Industry by the Southern California Section of the Institute of Food Technologists. The presentation was made at the first Fall meeting of the section held in Los Angeles on September 19. The presentation of this Certificate is made annually by the Section to the person it considers has contributed most to high quality food processing during the preceding year.

During the last decade, Knott's Berry Farm has become one of the outstanding tourist attractions in Southern California. One of the highlights of the 1954 IFT meeting at Los Angeles in 1954 was the enjoyable day spent there.

The background on the development of this enterprise was sketched to the Section by Mr. Knott. It proved to be in the classical Horatio Alger tradition. Thirty-five years ago, Walter Knott and his family rented 20 acres of land and commenced growing berries. Shortly after purchasing 10 acres of this land, the depression hit and the price of berries skidded downwards. Hearing of a seedling berry in the area, that bore exceptionally large fruit, Walter Knott succeeded in locating a few specimens and made the first commercial plantings. This berry he named Boysenberry in honor of its discoverer, Rudolph Boysen, who was Park Superintendent at nearby Anaheim.

Meanwhile, Mrs. Knott had commenced serving chicken dinners at the roadside stand where they sold their berries. This enterprise gained immediate public acceptance and from humble beginnings now averages 6000 dinners per Sunday. As many as 14,000 people in one day have been served.

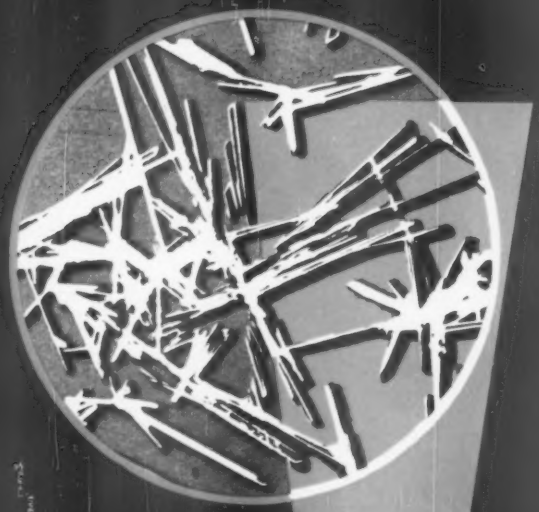
By 1940, both the berry farm and the restaurant were on sound financial footing and the Knotts decided to attempt to preserve some of the flavor of the old West. The construction of Ghost Town was commenced and it has been growing ever since. It now includes such diverse items as a railroad train from Colorado, cable cars from San Francisco, and a school house from Kansas.

After the Second World War, they commenced making jams and jellies and this phase of the enterprise has also grown to such an extent that they now pack over one million dollars worth of product annually. Half of this is in Boysenberry jam and jelly. Last year, wholesale distribution of these products was commenced and they now have over 400 outlets for these products.

TEXAS . . . .

COLLEGE STATION, September—The Guy W. Adriance Horticultural Laboratory was dedicated on the Texas A. and M. College campus last week. The $90,000 food processing laboratory was named for Dr. Adriance, head of the A. and M. Department of Horticulture since 1935.

(Continued on page 21)



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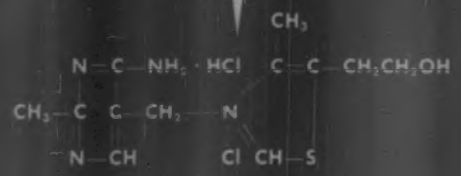

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Roche proudly produces vitamin B_1 under careful, constant control . . . packed to reach you quickly from convenient shipping points . . . unharmed, untouched, unsurpassed.

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(Illustration represents actual crystals under high magnification, using shadow technique.)

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1. **U. S. P.** Both 'Roche' thiamine hydrochloride and mononitrate equal or exceed U. S. P. specifications.

2. **TWO TYPES.** Roche has *two types* of thiamine hydrochloride available for you:

   Regular—*for tablets, capsules, dry and liquid nutritive supplements and multivitamin preparations.*

   Ampul—*specially prepared for use in manufacturing parenteral solutions.*

3. **SPECIAL PROBLEMS.** Roche has thiamine mononitrate to help you meet unusual stability problems which can occur in dry cereal or pharmaceutical products. Also it may have advantages in certain pharmaceutical products where the pH range is above the safe level for the hydrochloride.

4. **STEADY SUPPLY.** Because Roche makes *quality* thiamine by the tons, you can be sure of a steady, *quality* supply.

5. **RESEARCH.** Continuing world-wide research brings you the latest developments in vitamin knowledge.

6. **PRODUCTION CONTROL.** Scientific production control assures you of consistent, highest quality.

7. **QUICK DELIVERY.** Every order receives prompt careful service from convenient points. Transportation at lowest rate allowed and prepaid to destination. Special routings at cost. And you *know* you can count on our promises.

8. **PACKAGING.** Packed in polyethylene bags in ½ and 1-kilo tamper-pruf metal containers and in fibre drums up to 20 kilos for the hydrochloride, 35 kilos for the mononitrate. Small quantities in amber S.C. bottles. *Ampul type* thiamine hydrochloride is sealed under inert gas in 100 gram S.C. bottles and in ½ and 1-kilo tamper-pruf metal containers.

9. **KNOW-HOW.** Roche know-how on vitamins can help you with solutions to compounding and packaging problems.

10. **SAMPLES** and technical assistance are yours on request. Ask your Roche salesman or write the Vitamin Division.

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(Continued from page 18)

Dedication ceremonies were a highlight of two meetings on the campus—that of the Texas A. and M. College System Board of Directors, and of the Texas Section of the Institute of Food Technologists.

Dr. M. T. Harrington, System chancellor, in dedicating the building, said, "Guy Adriance is as much a part of the A. and M. System as it is possible for a man to be.

"Literally born on the campus, he is the son of Duncan Adriance, who was chemist for the Texas Agricultural Experiment Station, and the grandson of John Adriance, a member of the board of directors just before the turn of the century."

Dr. Adriance is a co-author of the definitive book, *Propagation of Horticultural Plants* which has gone through several editions, one revision, and still is considered an outstanding book in the field.

UNSUSPECTING HONOREE—Dr. Guy W. Adriance, head of the Department of Horticulture at Texas A. and M., speaks before a combined meeting of the Board of Directors for the Texas A. and M. College System and the Texas Section, Institute of Food Technologists, only moments before the department's new horticultural foods processing laboratory was named for him. At this point he did not suspect what was to happen. Dr. M. T. Harrington, chancellor for the System, announced the name of the building, the Guy W. Adriance Horticultural Laboratory, minutes later during his dedication address.

Ben Golub, of Houston, president of Belle Products Inc., served as spokesman for the Texas Section of the IFT in accepting the building. He remarked, "In 1949 the average supermarket shopper had a choice of approximately 1,400 food items. Now the same shopper has a choice of about 4,000. The average buyer is presented with about 10,000 new items per year.

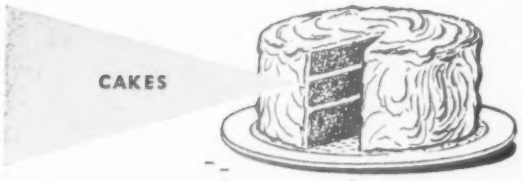
"Our experience is that we will get the new ideas and methods to stay in the market through the cooperation of this system and this department.

"We have had invaluable assistance from the college here; this sort of cooperation makes us feel wonderful in knowing the college is here to help us meet our problems. I know that we will get the needed lift to go on and produce more and better foods for Texans. We gratefully accept."

DIXIE . . . .

The Fall meeting was held on 5 October 1956 with 70 members and visitors being the luncheon guests of the H. W. Lay and Company at its new $1,800,000

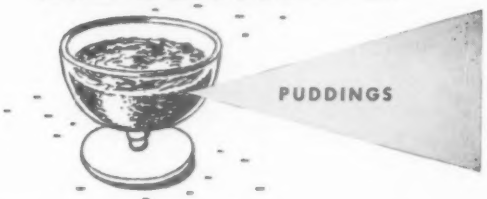
FINE FLAVOR



FORMULATIONS

FOR THE FOOD

INDUSTRY.....



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specialty-foods plant on Peachtree Industrial Blvd., Atlanta, Ga. After a brief story of the growth and development of the company, an extensive tour of this advanced-design plant was conducted by the officials of the company.

In the evening, dinner and a brief business meeting conducted by Pres. T. W. Kethley was held in the Cherokee Room of the Cherokee Hotel, Atlanta, with 51 members and visitors present. The meeting was completed with the showing of color films on the manufacture of Roquefort cheese, courtesy of the Roquefort Cheese Association, and the manufacture of macaroni, courtesy of Skinner's.

Mr. A. S. Perry, Section Program Chairman, arranged the excellent program and secured the film. This program pattern consisting of plant tours in the afternoon with dinner and relatively short meetings in the evening has been followed by this section for several years and has proven to be very satisfactory and popular as evidenced by continued good member attendance and distances traveled by many of the members. We recommend this type of program to the other sections. WILLIAM B. COWN, Editor

PERSONNEL

DR. C. C. STRACHAN, formerly of the Experimental Station at Summerland, B. C., has been promoted to the superintendency of the Morden Experimental Farm at Morden, Manitoba Dr. Strachan was granted his Bachellor's degree by the University of British Columbia, obtained his Master's at Oregon State College, and was awarded his doctorate by the University of Massachusetts. Dr. Strachan has actively contributed to the advancement of food processing in Canada, having done much of the basic work leading to the commercial development of vitaminized apple juice (now a 3 million dollar industry). He has also been closely associated with Canadian developments in the fields of dehydration, freezing, and canning of fruits and vegetables.

DR. M. S. CHAN, who received his doctorate last June from the University of Massachusettes, is presently Associate Scientist at the Gaspé Technological Station, Fisheries Research Board of Canada, Grande Riviere, Quebec. He is engaged in research on fish with current emphasis on the hydrolysis of proteins. Future work will include fish dehydration studies under the program of the Industrial Development Division of the Department of Fisheries.

On September 1, 1956, by action of the Gentry Executives Committe, ARTHUR N. PRATER, Ph.D., became president of the Gentry Division, Consolidated Foods Corporation. He succeeds George E. Clausen, Sr., who will continue as Chairman, Executive Committee of Gentry.

Dr. Prater, a professional member of IFT since its beginning, has been closely associated with Gentry management since 1944. Elected a vice president in 1954 and executive vice president in 1955, he assumes his new office with extensive experience in company planning, policies, and operations. He has been able to contribute in the past, and will continue to do so in the future, to both the business and the technical program of Gentry.

Dr. Prater earned his Ph.D. at the California Institute of Technology. Subsequent to that event he has remained vigorously active in the scientific world as is evidenced by numerous contributions to our fund of knowledge on chemical and physico-chemical problems of foods and by his participation at the national level in the work of the professional societies—the American Chemical Society and the Institute of Food Technologists as prime examples. He has been president of the Research and Development Associates, Food and Container Institute, a public service organization that has been extensively utilized by the Department of Defense in the advancement of military foods and packaging; a national officer of the Institute of Food Technologists as well as chairman of several key committees of our Institute; and program chairman for both the American Chemical Society (food and agriculture division) and IFT (chairman, 14th annual meeting, Los Angeles).

FLORASYNTH FELLOWSHIP

The Florasynth Fellowship ($1000) granted annually, was established to honor and assist an outstanding individual engaged in advancing food technology. Candidates are nominated for this award by heads of college departments. Nominee must be a U. S. or Canadian citizen, under 35; a senior undergraduate, or one engaged in graduate work for an advanced degree; and enrolled in a recognized U. S. or Canadian institution conducting fundamental investigation for the advancement of food technology.

The Award is for the academic year. Brief written interim reports may be required. A final report, which can be in the form of a thesis or publication, is required. Awardees are selected by the Institute of Food Technologists Committee on Awards. Selection is based on outstanding qualities of character and personality, demonstrated scientific or engineering ability in the field of food technology, and a better than average scholastic record.

(Continued on page 24)

THEY LOOK SO GOOD . . . the wonder is that any housewife can long resist the tempting food products displayed in today's exciting consumer advertising. Truth to tell, not many of them do . . . and so, this pictured promise of mouth-watering satisfaction *has to be fulfilled*. Ready to help the manufacturer meet this obligation is the supplier whose flavors ultimately determine the taste-character and quality of the finished goods. In choosing such supplier, remember that reputation, reliability and experience are your safest guides. Remember, too: *Your product is* ONLY *as good as its* FLAVOR!

If interested in special flavor applications – pie or cake filling, dessert powder, food or beverage – write our Flavor Division, Dept. FT.

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BRANCH OFFICES *and* *STOCKS: *Atlanta, Georgia, Boston, Massachusetts, *Chicago, Illinois, Cincinnati, Ohio, *Los Angeles, California, Philadelphia, Pennsylvania, San Francisco, California, St. Louis, Missouri, Montreal and *Toronto, Canada and Mexico, D. F.* FACTORY: *Clifton, N. J.*

(Continued from page 22)

Procedure for applying. Nomination for this fellowship is made to the office of the Secretary of the Institute, in behalf of the proposed candidate, *by the Head of the Department* who supervises the undergraduate or graduate work of the candidate. Nomination must be in letter form, giving the customary essential personal and academic information with respect to the candidate. Educational and experience background, college or university scholarship record in transcript, noteworthy accomplishments in research, and reasons for proposing the candidate for the fellowship should be included.

Nominations must be received by the Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois, prior to February 1, 1957.

THE GERBER BABY FOODS SCHOLARSHIP ($1000)

Six Gerber Baby Foods Scholarships ($1000 each) are available in 1957. Applicants must be United States or Canadian citizens. The Award is intended for students working toward a Bachelor's degree in Food Technology, Food Engineering, or Food Science.

Procedure for applying. Apply in letter form, giving the essential personal and academic information. Applications must be received by the Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois, prior to February 1, 1957.

For complete details, see page 10.

THE GENERAL FOODS FUND FELLOWSHIPS

The three General Foods Fund, Inc., Fellowships, established to promote outstanding scholarship, are awarded to United States or Canadian citizens, engaged in senior undergraduate or graduate work in recognized educational or research institutions in the United States of America or Canada, in basic or applied chemistry, chemical engineering or related sciences, which may involve new physical or other procedures, directed to extending or improving knowledge in some phase of food conservation, food production or food processing, rather than primarily for research in the fields of nutrition, bacteriology or analytical chemistry.

Selection is based on the candidate's scholastic record at an institution of recognized standing and an approved plan of research in Food Technology. Acceptance by the Graduate School of the institution in which the applicant proposes to hold the Fellowship is also required.

Each Award ($4000) is for the full calendar year. Brief written reports (in duplicate) on progress may be required. A final detailed report, which may be in the form of a thesis or published paper, will be required (in duplicate) from each fellow.

How to apply. Apply in letter form, giving the customary essential personal and academic information. Include: name, nationality, sex, age, marital status; physician's statement with respect to the general health and physical condition; educational and experience background, college or university scholarship record; noteworthy accomplishments in research; purpose in applying for Fellowship Award.

Three letters of recommendation shall be forwarded separately to the Office of the Secretary of the Institute by Deans, Heads of Departments and/or Professors, who have supervised work of the applicants. These letters should present essential facts regarding the scholarship or record transcript thereof, character and personality, ability to cooperate and capacity for work and achievement of the applicants. Required also is a statement by the Head of the Department where the work will be done, endorsing the applicant and accepting for the school the responsibility connected with the acceptance of the Fellowship Award.

Mail your application and supporting papers prior to February 1, 1957 to:

Executive Secretary
Institute of Food Technologists
176 West Adams Street
Chicago 3, Illinois.

MASTERS AND DOCTORS IN FOOD TECHNOLOGY AND RELATED SUBJECTS

OHIO STATE UNIVERSITY AT COLUMBUS

A further installment of degree winners in the field of food technology and related subjects is herewith presented.

Name	*Degree*	*Title of Thesis*
Abdul-Wahab, Nadhim S.	M.S.	The Influence of Heat Treatment on Flavor, Color, and Some Chemical Constituents of Maple Syrup
Bassett, E. W.	Ph.D.	Acidic and Neutral Carbonyl Compounds in Various Cheese Varieties
Cole, Leslie J. N.	Ph.D.	Chromatographic Procedures for the Isolation of the Original Constituents of Natural Waxes, with Special Reference to the Study of Ouricuri Wax
Fox, K. K.	Ph.D.	Effect of Heat on the Electrophoretic Properties of Milk Proteins
Geisman, J. R.	M.S.	An Evaluation of Methods of Drosophila Fly Egg and Maggott Recovery
Mavis, James O.	Ph.D.	Color Measurement of Tomato Juice and the Adaptation of a Reflectance Instrument, Agtron (Model F), for Continuous Color Evaluation
Ng, Keng Chock	Ph.D.	The Relation of Cultural Practices to the Specific Gravity and Calcium Content of Potatoes and the Effects of These Variables on the Quality of Potato Chips
Poshachinda, Kaisri	M.S.	The Effect of Certain Amines on the Water Holding Capacity of Meat Protein
Read, Merrill S.	Ph.D.	The Effect of Hormones on the Intermediary Metabolism of Mammary Glands
Iwao, Sato	M.S.	Certain Factors Affecting the Freezing Point of Milk

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Not a day passes but that we are consulted on ways to improve products. Whether it be a color or flavor problem, our staff of experienced technicians are ready to serve you.

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● Every meal she sets on her table must meet two basic requirements . . . it's like second nature to her: a meal must be *appetizing* and *health-providing*. With these goals in her subconscious, what happens in the store?

The grocery store is the proving ground of competition. *Hundreds of powerfully advertised brand names compete for her favor,* for her judgment of what will provide appetizing, health-providing meals. That's when your food product needs *a plus on the label,* a signal to her health-consciousness!

"Vitamin Enriched," "Vitamin Fortified." Those signals, those words can make a big difference today in moving *your product* to her table. Why not let a Pfizer representative tell you *in his words* the full details on how Pfizer vitamins can significantly increase your product's sales potential. Pfizer has been a major vitamin research and production center since the first vitamin was commercially produced.

Here are just 3 examples of food products that are increasing sales with Pfizer vitamins:

A health plus on the label of carbonated beverages says "Vitamin Fortified" *(and means sales).* With Pfizer Vitamin C and Vitamins of the B Complex fortification costs just a fraction of a cent per bottle.

Pfizer experience can help you put the health

MOVES PRODUCTS TO HER TABLE

A health plus on the label of flour, macaroni and similar products says "ENRICHED" *(and means sales).* New light-color Pfizer BI-CAP is now simplifying the problem of enriching white flour for many millers.

A health plus on the label of canned juices and concentrates says "Vitamin Fortified" *(and means sales).* Fortification here will offset processing losses and seasonal variations in natural vitamins.

* * *

What's the most powerful *plus* you can offer the food shopper? It's those extra health words on your label. Let Pfizer help you put them there.

Quality Ingredients for the food industry for over a century

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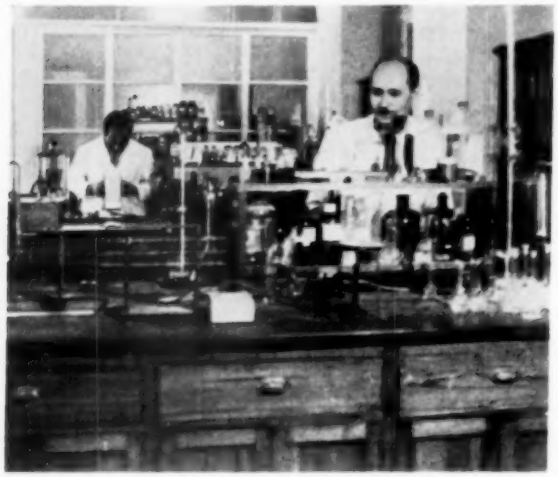
Training Food Technologists at the University of Alexandria

A. M. El-Tabey Shehata and M. Aref
Agricultural Industries Department, College of Agriculture, Alexandria, Egypt

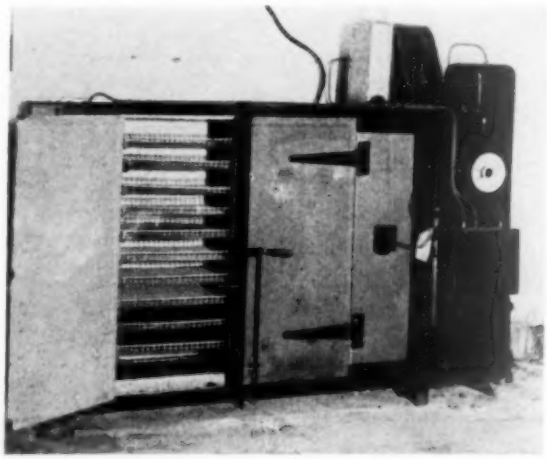
ALONG WITH THE MARKED ADVANCES being made in Egypt today has come an immense shift in capital investments. Capital tied up for centuries in agricultural estates is now being judiciously applied to the expansion of existing industries and to the establishment of new ones. As elsewhere in the world, there is an urgent need in Egypt for technically trained manpower to keep abreast of this evolving industrial trend. The educational institutions of Egypt are cognizant of the problem and are seeking to alleviate it. With regard to the food industries of the nation they are becoming the main source of supply for trained food technologists.

Fortunately, these institutions are fairly well equipped. They are staffed with personnel who can meet the challenge. Most of the faculty engaged in training food technologists at the Egyptian universities have been trained in the United States, the hub of food technology. The educational policy, initiated in Egypt many years ago, of sending university graduates abroad for further training and study is now paying off. Increasing application of science, technology, and engineering to the various phases of food processing is now in evidence.



Research Laboratory

The first course in food technology to be taught in Egypt was introduced into the general curriculum of the College of Agriculture, Cairo University, by Professor H. Aref in 1936. Since then, more attention has been given to the subject. When the University of Alexandria was founded in 1942, a department of food industries was instituted by Professor A. Sedky. He has recently been appointed managing director of Edfina Food Manufacturing and Export Company, which will start operations late in 1956. Besides this new establishment, there exist in Egypt several other food plants, presently producing limited amounts of canned vegetables and fruits, dehydrated onions and garlic, soft beverages, beer, wine, candies, etc. Other new plants are expected to be founded in the very near future.



Laboratory Dehydrater

Since the establishment of the food industries department at the University of Alexandria, certain modifications have been made in the curriculum to meet the changing conditions and needs of the industry. Due to the limited number but diversified nature of the food plants existing now in Egypt it was thought best to give the student not only a well-rounded knowledge of the fundamental principles of the basic sciences but in addition a fair skill in food processing methods. The present curriculum is designed to produce graduates of professional calibre but equipped with a versatile and practical background adapted to the growing needs of the Egyptian food industry. As the great industrial expansion continues, this new curriculum will be put to test on a large scale and no doubt changes will have to be made in accordance with presently unforeseen demands. It is already becoming apparent, for example, that more emphasis on engineering is desirable.

NATURE AND SCOPE OF FOOD TECHNOLOGY TRAINING IN EGYPT

The required courses for the four-year curriculum leading to a B.S. degree in food technology at the College of Agriculture, University of Alexandria, are presented in Table 1.

(Continued on page 30)

Flavors blend better with

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MALIC ACID

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An excellent acidulant with all fine qualities of citric or tartaric acids *plus* the extra advantage of better blending properties. Its palatable taste combines perfectly with apple and other fruit flavors, essences or ginger, blending in a single, very agreeable flavor. National Aniline Malic Acid analyzes 98.5% pure, makes clear solutions which do not affect the color of end-products.

Technical assistance is available and we shall be glad to send detailed specifications and a working sample on request.

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Los Angeles Columbus, Ga. New Orleans Chattanooga Toronto

(Continued from page 28)

The courses given in the first year are attended by all students who enroll in the College of Agriculture. Those electing to study food technology must maintain a B average, *i.e.*, they must attain this grade in at least seventy percent of their total hours during the first year of their studentship.

Though the food technology curriculum starts in the second year, most of the courses given in that year are of a general nature in order to familiarize the students with the raw materials they will handle.

TABLE 1
Undergraduate curriculum in food technology

First Semester	*No. of Units*	*Second Semester*	*No. of Units*
		First Year *	
General Botany 1A	4	General Botany 1B	4
Chemistry 1A	5	Chemistry 1B	3
Economics 1A	3	Economics 1B	3
Geology	3	Physics	3
Analytical Geometry	2	Calculus	2
		Zoology	5
	17		20
		Second Year	
Agronomy 1A	3	Agronomy 1B	3
Agricultural Economics	3	Organic Chemistry	5
Bacteriology	4	Horticulture	4
Entomology	4	Truck Crops	4
Dairy Science	4	Animal Breeding	3
	18		19
		Third Year	
Plant Physiology	3	Food Analysis	5
Biochemistry	4	Canning	4
Principles of Food Preservation	5	Freezing and Dehydrating	4
Food Microbiology	4	Dairy Products	4
Ice Cream and Concentrated Milk	3	Dairy Microbiology	3
	19		20
		Fourth Year	
Nutrition	3	Food Control	3
Industrial Fermentations	4	Packing and Storage of Fruits	2
Farm Crop Industries	4	Food Engineering	3
Dairy Chemistry	3	Colloidal Chemistry	4
Marketing of Agricultural Products	3	Special Problems in Food Technology	2
	17		14

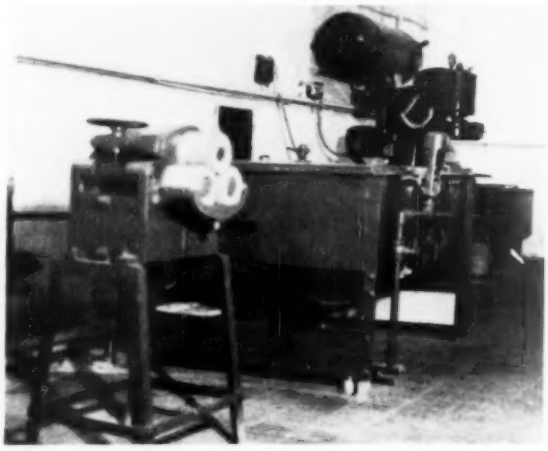
* The academic year includes two semesters of 14 weeks each; 1 unit equals one class hour or 2 laboratory hours per week/per semester.

In the third and fourth years, extensive courses are given in chemistry, microbiology, and the technology of foods. In addition, special emphases are given to food engineering, biochemistry, nutrition, plant physiology, and colloidal chemistry. Also a few courses in dairy science and technology are presented in detail.

ADDITIONAL TRAINING FEATURES

The technological courses include visits to food plants located in and near Alexandria. Guided tours furnish a kind of practical laboratory experience, and the students have to submit detailed reports on what they have observed. During the two weeks' vacation between semesters, the students of the fourth year are taken on an educational tour throughout the country, visiting the important agricultural and industrial establishments. An excellent perspective on the food economy—from point of origin to consumption—is thereby attained.

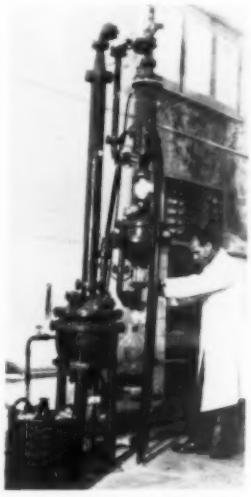
In the final semester, a special problem is assigned to each student. This is intended as training for research



Section of Pilot Plant

to overcome anticipated technical difficulties and the problems likely to be encountered in future jobs. Each student has to submit an extensive analytical report on his problem—stating his own observations, conclusions, and solutions. To accommodate this important feature of his training, the number of units taken by the student in the last semester is reduced.

Although graduate studies leading to the M.S. and Ph.D. degrees are offered by this department, at present only a few students are enrolled for the first and none for the latter degree. There is no fixed curriculum for achieving these higher degrees since the requirements vary according to the specific interest and the undergraduate background of the candidate. Two years of residence are the minimum requirements for the master's and four years for the doctorate. The studies for these degrees include advanced courses, training for research, and original investigations.



Distillation Assembly

We believe that both science and technology are essential for a successful career in food technology, and if either needs to be more stressed it should not be at the expense of the other. It is abundantly clear that the expansion of the Egyptian food industries will require professional training broad enough in scope to solve basic scientific problems as well as problems, often as difficult, in the field of technology.

THE Sealva STORY OF "Sealed-In" Flavors

Some years ago, van Ameringen-Haebler, Inc. developed and introduced SEALVA Flavors, the first truly hermetically "sealed-in" high quality dry flavors. This new technique in flavor-making was immediately recognized and enthusiastically accepted by the food industry.

Since those early days, continuing improvements in sealing agents and drying techniques plus the basic superiority in the quality of the natural or imitation flavors themselves, have combined to maintain SEALVA's place as the ultimate in fully protected quality flavors.

What can SEALVA do for your product?

The adoption of SEALVA Flavors makes possible the use of absolute top quality flavor in dry mixes, because the finest of flavors are fully protected in their powdered form against the ravages of deterioration caused by evaporation, oxidation, extended shelf-life, and they are practically impervious to chemical reaction with other ingredients in a mix or compound.

Where can SEALVA Flavors be used to advantage?

SEALVA Flavors are ideal in any relatively dry, powdered, grained, or flaked mixture to insure inert flavor retenticn in such products as cake mixes, gelatin desserts, cereals, drink powders, pudding mixes, dairy mixes, ice cream mixes, candies (pressed wafer), pharmaceuticals, proprietaries, oil emulsions, etc.

For better flavor we ask you to investigate SEALVA Flavors before you make your final decision on this most important ingredient.

We are prepared to give you suggestions as to the methods of readily evaluating "sealed-in" flavors for your particular product and also will be happy to assist with technical recommendations for the application of SEALVA Flavors to improve your product. Literature and adequate samples are available.

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BOOKS . . .

PLANT PHYSIOLOGY. By Meirion Thomas, with collaboration of S. L. Ranson and J. A. Richardson. 4th Edition, Revised. Philosophical Library, Inc., New York, 1956. 692 pp.

This well prepared book is up to date, and the biochemical aspects of plant physiology are fully discussed throughout. It is, therefore, valuable from the biochemist's point of view.

The book is divided into four parts. Part I covers protoplasm. The living cell, protoplasm, and the conditions for protoplasmic activity are considered. Much of this part is devoted to the actions of the enzymes involved. The last chapter of this part concerns the Krebs cycle. Part II considers the absorption, translocation, and elimination of water, solutes, and gases. Part III deals with nutrition and metabolism, and discussions of micronutrients and soils, chemical composition of plants, and biochemical changes are included. The important subjects of respiration and photosynthesis are given lengthy treatment. Part IV, which includes growth and movement in plants, quite fully discusses these subjects, as well as plant growth substances.

The appendices give helpful notes on the chemistry of metabolic products and physical chemistry, as well as some special physical and chemical techniques.

This book is documented with 748 references.

It is recommended as a valuable reference book for food scientists working on vegetable materials.

FRANK A. LEE
Geneva, New York

ADVANCES IN PROTEIN CHEMISTRY. Edited by M. L. Anson, K. Bailey and J. T. Edsall. Vol. 10, pp. 1-425, Academic Press Ind., N. Y., 1955.

This series forms a most valuable source of information on a general subject which should be of interest to most food technologists, and the present volume has maintained the high standard set by its predecessors. It contains six informative articles, two of which deal with fish proteins. The chapter by G. Hamoir is the first really informative and detailed review which has dealt with fish proteins. It is well written, and though emphasis is laid on the application of modern techniques of electrophoresis and ultracentrifugation, there is fairly adequate coverage of the literature on such subjects as enzymes, protamines and blood proteins. Since it is generally conceded that no specfic "lipoxidase" exists in fish muscles, the author might be criticised regarding his coverage of this subject. The chapter dealing with "The sea as a potential source of protein food" is inclined to be sketchy and not entirely up to date. Thus the figures given in the two tables which deal with amino acid distribution in fish and shell-fish protein cannot be considered a good recent summary of presently available literature. There are also misleading statements such as the one which suggests that "high grade fish meal contains as much as 60% protein," where 70% is probably a more accurate value. The chapter dealing with "The nature of phosphorus linkages in proteins" is timely in view of the present dynamic interest in the importance of phosphorus compounds in biochemistry. There is valuable treatment of those phospho-proteins of nutritional importance: casein, vitellin and vitellenin. Three other chapters deal with "Metabolism of aromatic amino acids," "Hydrogen ion equilibria in native and denatured proteins" and "Zinc metalloenzymes."

H. L. A. TARR
Vancouver, Canada

HUTCHINSON'S FOOD AND THE PRINCIPLES OF DIETETICS. Eleventh Edition. Revised by V. H. Mottram and George Graham. The Williams and Wilkins Co., Baltimore, Md.

The 11th edition of Hutchinson's, *Food and Principles of Dietetics* is a comprehensive overview of nutrition and dietetics. It is a text well suited for reference use by the college student of normal nutrition and diet therapy.

The chief concerns of this book are food composition, food processing, and the physiology, economics and hygiene of food. Material for the new edition includes recent advances in energy, protein and mineral metabolism. In addition, changes are found in the chapters on the processing of food, both commercially and in the home, food sanitation, and the selection of food for groups of limited income. Chapters have been rewritten on the dietary treatment of sprue, diabetes mellitus, diseases of the liver and disturbances of the circulatory system. New sections are devoted to the treatment of allergies, malignancies, and post-operative conditions.

Information contained in this text is well documented with research references. Throughout the book there are numerous footnotes of an explanatory and practical nature. These are written in an informal fashion and add color and interest to factual material.

This British treatise on nutrition is recommended not only for its sound information but also for the knowledge it imparts on the way of life of another nation. It is regrettable that the authors have indicated in their preface that this is their last edition of this book.

BEATRICE FINKELSTEIN
Dayton, Ohio

In Memoriam

It is with great sadness that we report the death of Dr. Henry Reist Kraybill, internationally noted research scientist and educator, on Sunday, September 30, at Billings Memorial Hospital at the University of Chicago. Dr. Kraybill, 65, had been ill for several months.

During his professional career of more than 40 years as a research scientist, teacher and administrator, Dr. Kraybill made scientific contributions of major significance in both plant and animal fields and in the development of biochemical science. He was responsi-

(Continued on page 34)

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(Continued from page 32)

ble for the organization of departments of agricultural chemistry and development of a teaching curriculum for these departments at both the University of New Hampshire and Purdue University.

Dr. Kraybill's death occurred at the apparent zenith of public recognition of his professional accomplishments. Purdue University, during commencement exercises in Lafayette, Ind., on June 3 conferred on him an honorary degree of Doctor of Science "in recognition of his devoted service to this (Purdue) University and for his distinctive achievements as a scientist, teacher and administrator whose contributions to biochemistry, plant production and food processing have advanced the science of agriculture, resulting in benefits to all people." Just prior to his death, he received notification that he had been designated as the recipient of the 1956 Dodge & Olcott Award in recognition of scientific accomplishments of outstanding and lasting significance in connection with the processing of meat and meat products. This award was bestowed in specific recognition of development by Dr. Kraybill and his associates at the American Meat Institute Foundation, research organization affiliated with the University of Chicago, of two food-grade antioxidants capable, first, of forestalling development of rancidity in lard and other meat fats and, second, of providing "carrythrough" protection again rancidity to foods made with meat fats.

Dr. Kraybill came to Chicago from Purdue in 1941 and held three professional appointments at the time of his death. Since 1941, he has served as director of the department of scientific research of the American Meat Institute and professorial lecturer in the department of biochemistry at the University of Chicago. Since 1947, he also has been director of research and education of the American Meat Institute Foundation and vice president of the research organization since 1955.

Dr. Kraybill was particularly well known for his work on meat processing, oils and fats, antioxidants, phosphatides, sterols and the effect of processing on the nutritive value of meat. Among his more important research contributions through the years were: His study of the re-sweating of Pennsylvania seedleaf tobacco which showed that the increase in ammonia-nitrogen was in part due to deamination of amides; with E. J. Kraus, the relation of carbohydrate and nitrogen metabolism to growth and reproduction in plants; with two Purdue research workers, the discovery of the symptoms of tryptophan deficiency in the white rat—believed to be the first description of an amino acid deficiency in animals; with J. H. Mitchell, Jr., development of a spectrophotometric method for quantitative determination of the fat-acid composition of fats; and with Spaeth, diagnosis by biochemical means of the false blossom disease of the cranberry as a virus disease.

Dr. Kraybill was born May 1, 1891. He is survived by his widow, Ruth Grove Kraybill; three sons, Henry L., a physicist at Yale University; Richard R., a chemical engineer at the University of Rochester; and Donald P. Kraybill, Chicago. He also is survived by three brothers and two sisters: Ira Kraybill of Jenkintown, Penna., Elmer K. Kraybill, Elizabethtown, Penna., and Dr. Clarence Kraybill of Manheim, Penna.; Miss Ida Kraybill of Mt. Joy, Penna., and Mrs. Anna Risser of Bainbridge, Penna.

The sorrowful news of the death of Clarence Birdseye on October 7, 1956, came as a shock to his host of friends in the food industry. Although he had suffered a heart attack a year ago, he appeared to be on the road to recovery.

Clarence Birdseye was born in Brooklyn, New York, in 1886. He attended high school in Montclair, New Jersey, and received college training at Amherst College during the period 1906-1910.

His distinguished career as a food technologist and inventor received its initial impulse in the Labrador where, cruising with the famous medical missionary, Sir Wilfred Grenfell, he noted that foods quickly frozen in the Labrador cold kept perfectly until the Spring thaw. It is said that he then and there conceived the idea of quick frozen fresh fish, as a commercial enterprise. He carried the idea to Gloucester, Massachusetts, the most promising spot for experimental work, and by 1923 the Birdseye Seafoods Company was a reality.

Clarence Birdseye was selected by an IFT jury in 1949 to receive the distinguished Stephen M. Babcock Award of the Nutrition Foundation and at the San Francisco meeting of the Institute was presented this honor by H. C. Diehl, then president of IFT. Birdseye was a distinguished member of many technical societies —the American Fisheries Society, the American Society of Refrigeration Engineers, the American Society of Mechanical Engineers, the American Society of Mammalogists, the American Institute of Refrigeration, and the Institute of Food Technologists.

The quick freeze food process invented by Clarence Birdseye is one of the greatest advances in food preservation of this century. It has made not only fresh fish available the year around but also fruits, vegetables and innumerable other products. The process has also made an outstanding contribution to the food economy of the U. S. A. and of the world. It revived the ailing fish industry of New England, gave new life to the fruit and vegetable industry in all regions of the nation, and made possible the great success of frozen concentrates. In the passing of Clarence Birdseye, this nation and the world have suffered the loss of a great inventive mind and a great benefactor.

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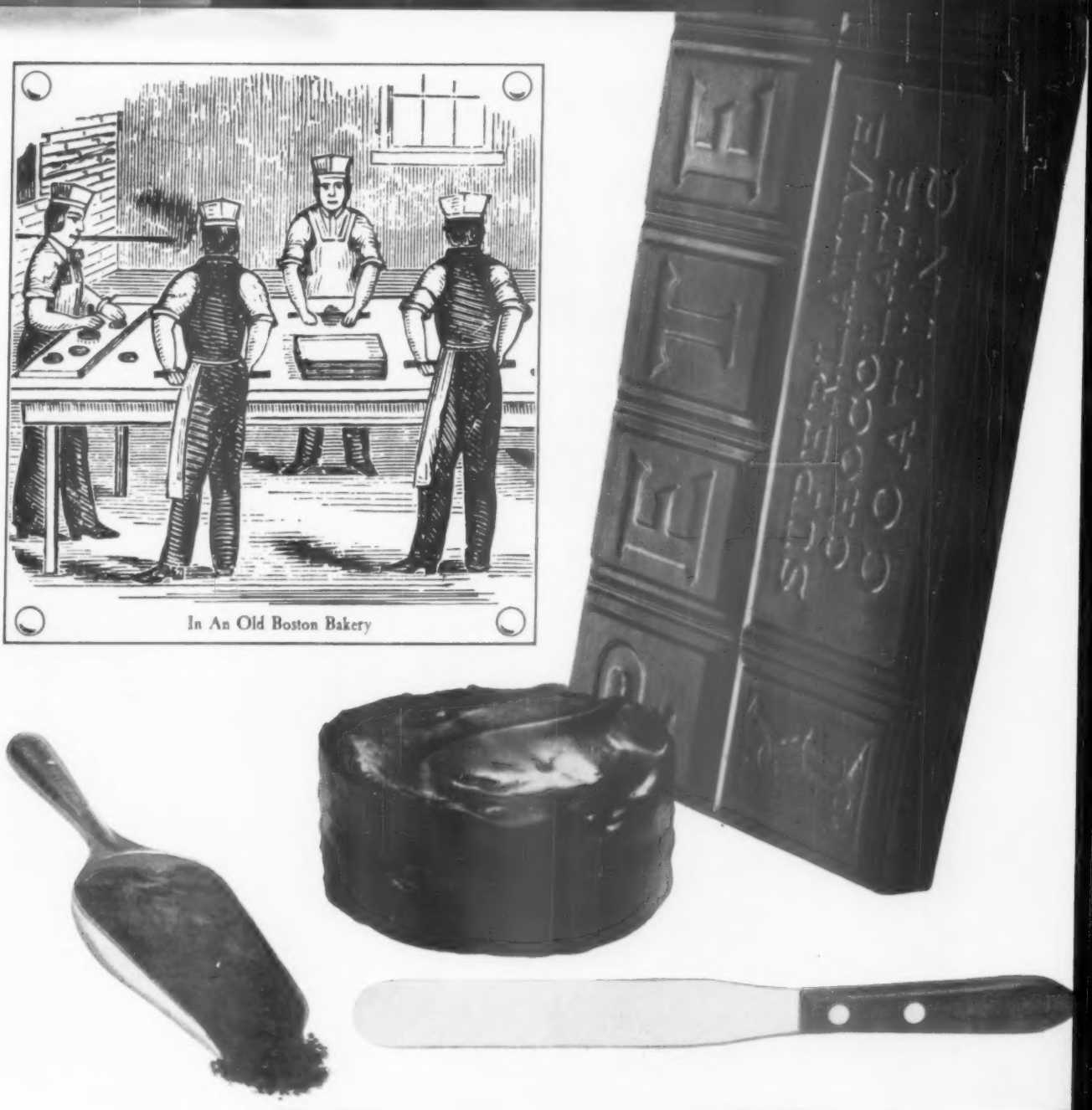

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Evaluation of Microbiological Standards for Foods[a]

G. M. Dack, Ph.D., M.D.
Director of the Food Research Institute,
The University of Chicago

THE INTERPRETATION OF MICROBIOLOGICAL DATA on classes of foodstuffs can be erroneous when applying knowledge obtained from one class of foods to another. Within the separate food commodities, individuals concerned with public health have given thought and consideration to microbiological standards. Thatcher *(12)*, of the Food and Drug Directorate of Canada, has presented an excellent paper "Microbiological Standards for Foods: Their Function and Limitations" at a symposium under the auspices of the National Research Council of Canada. He made the following statement: "The bacteriological picture if adequately portrayed shows the significant effect of unsanitary conditions and should be the preferred indicator of hygienic attainment. To provide objectivity and legal weight to expedite enforcement, microbiological standards are needed to indicate the degree of cleanliness of pertinent factory surfaces and of the hygienic efficacy of practice." Again, Mossel *(10)*, who has been active in keeping the subject under discussion in the International Society of Microbiology, has discussed and reviewed the literature.

With the rapid development of new methods in processing foods many phases of the microbiological aspects of the problem may be neglected only to bring grief to the processor at a later time. The production of a high quality product may require stainless steel equipment having a minimum of valves, and smooth rounded surfaces which are easily cleaned. The processing plant should be constructed so that rodents and insects do not have access to the product or environment. An abundance of potable water and steam are necessary adjuncts to processing high quality foods. These requirements may be expensive but usually repay themselves by the production of high quality products and less spoilage.

MICROBIOLOGICAL STANDARDS—FACTORS IN THE TOTAL PROBLEM

Microbiological standards at the present time are restricted to fluid milk, ice cream, egg products, tomato products, and shell fish. Cheese not made from pasteurized milk is required to be stored for at least 60 days before sale. Microbiological standards have been established by the Armed Forces in specifications for such foods as dried egg powder, in-flight frozen meals, meringue powder and canned margarine *(1)*. The National Canners' Association has developed standards for their members' voluntary use for the presence of flat sour and thermophilic spores in sugar, flour, and starch. These standards have proved their worth in reducing spoilage in canned products.

In contemplating the problem of microbiological standards in foods one must give thought to the origin of the microorganisms in the product. The soil upon which plants grow is teeming with microbial life. Animal manures are often added to the soil to increase fertility. Soil therefore is potentially a source of contamination of food not only with its own saphrophytes but with microorganisms of animals. Further, the handling of foods contributes not only spoilage bacteria but pathogens of man. In a processing plant suitable time and temperature may provide for rapid multiplication of microorganisms in a perishable product. Cracks or crevices in the equipment may allow for accumulation of debris so that there may be a rapid multiplication of spoilage bacteria which in turn may affect the quality and lead to a high rate of spoilage in the product. A few unsound fruits or vegetables in a shipment may provide large numbers of spoilage microorganisms which may be reflected in a higher total bacterial count. In foods that were sun dried, higher bacterial counts were found than where better sanitation methods and drying in commercial dehydrators was employed *(11)*.

From the public health standpoint the application of microbiological standards as far as the safety of a food is concerned may not necessarily be related to the number of saphrophytic microorganisms it contains. There have been outbreaks alleged to be caused by Salmonella which have implicated dried food products both of plant and animal origin, where the total bacterial counts were low and where only small numbers of Salmonella were present. Many perishable foods contain the spores of *Clostridium botulinum*, *Cl. perfringens* and *Bacillus cereus* as well as Salmonellae, enterotoxigenic micrococci and alpha-type streptococci, all of which have been associated with food poisoning. At present it is neither feasible nor practicable to establish microbiological standards for these microorganisms in all food products. For example fresh poultry, pork, shell eggs, lettuce, celery and the surfaces of fruit may contain pathogens but experience in the United States has not indicated that they present a serious health problem.

Botulinum toxin or staphylococcal toxin is not tolerated in any item of food. In the case of enteric pathogens, Salmonella and dysentery bacilli we do not want any of these living organisms in foods, especially in perishable food in which they may multiply. With reference to alpha-type streptococci, *Cl. perfringens* and *B. cereus* it is only when large numbers of some of these strains of bacteria are present that illness results. Therefore large numbers of these living bacteria should not be present in the foods we eat.

A number of the common foods are cooked before serving. This is true of fresh meats, fresh and frozen vegetables, some fruits and cereal products. Ready-to-eat meat products, lettuce, celery, some dried products and fruits, however, are eaten without cooking. Foods that are handled are bound to receive organisms from the hands including fecal organisms, enteric pathogens, and other pathogens. Washing with potable water removes some of the microorganisms. At times the products do not provide suitable conditions for the survival of pathogens or they do not constitute a medium

[a] The Babcock-Hart Award Acceptance Address, presented before the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 11, 1956.

in which these microorganisms may multiply. Many foods containing fecal bacteria may be eaten without causing illness. Where enteric pathogens are present people may be spared but if the dosage level of these organisms in a food is high, large numbers of people eating the food may become ill. In products which are uncooked before serving it is therefore advisable for the processor to have microbiological standards to gauge the wholesomeness of his product, especially where pathogens may survive and multiply before the food is eaten. Many processing methods are being developed to destroy contaminating microorganisms and better methods and equipment are being developed to avoid handling of the product after its decontamination.

Public Health people have sometimes attempted to apply microbial standards which have been developed for water, milk, and carbonated beverages to other foods. The nutrients, bacterial flora, and the pH in the latter food items are all factors which may affect the detection of microorganisms such as *Escherichia coli* and *Streptococcus faecalis* as indicators of fecal pollution. Since many food items are handled in processing, organisms of fecal origin are introduced into the food. Any processing procedure should be taken which eliminates handling during the preparation of foods which are eaten without cooking. Obviously there are instances where handling is unavoidable. Microbial standards for a ready-to-eat processed food would necessarily be different from standards evaluating a raw food supplied to a food processor by Agriculture.

A distinction and proper evaluation should also be made between spoilage microorganisms causing incipient or frank changes in organoleptic characteristics, and food poisoning bacteria when viewing and weighing hygienic attainment.

Microbial standards may reflect the time and temperature a perishable product may be held on the production line or the inadequacy of cleaning equipment in contact with perishable food. An example of time and temperature was reflected in a dried skim milk powder which contained staphylococcus enterotoxin. In one such instance milk was evaporated and held in a tank at a temperature favorable to the growth of micrococci too long a period before spray drying. Thus the product from the plant after 9 hours operation on 2 successive summer days contained micrococcic enterotoxin *(9)*.

MICROBIOLOGICAL STANDARDS FOR FROZEN FOODS

Best use for microbiological standards for frozen foods would probably be that which has been self-imposed by industry for in-plant operations. In the case of the frozen citrus juices it is imperative if the quality of a product is to be maintained that a very careful check during processing of the microbiological numbers in the product be established.

A large rise in number of microorganisms is associated with deterioration in the quality of the product. Successful production of a high quality product has necessitated the type of equipment and care that is required in the handling and processing of fluid milk. Although small numbers of coliform organisms have been found in canned frozen orange juice, when the product is thawed and allowed to stand these coliforms apparently die. Furthermore no food poisoning illnesses have been associated with the consumption of frozen citrus juices *(2)*.

Microbiological standards for frozen foods would be difficult to interpret since while the counts during freezing decrease, the rate of decrease varies with different organisms and products *(1, 5, 8)*. Thus if a legal microbial standard was applied, a processor with a product above the standard might reach the standard by shifting the temperatures of freezing and varying the holding period. Dr. Kenneth Dykstra *(3)* has supplied the author with data on 1144 samples of frozen vegetables representing 56 brands from 19 cities. The relationship between flavor grades and bacterial counts was determined. The number of bacteria found represented the types picked up from the equipment rather than from the growth of bacteria in or on the product. This is reflected by an almost negligible count on the product coming from the blancher to a level of thousands in the few minutes required for packing.

Dykstra's unpublished study included string beans, lima beans, corn, peas, spinach, and mixed vegetables *(3)*. With these products flavor was scored in five categories ranging from *excellent* to *poor*. In general the better quality of a product was associated with a higher bacterial count. The reason for these results has not been established. Two possible explanations are offered: (a) that A grade material runs more or less continuously through the plant, whereas lower grade material is run more or less sporadically and for a shorter period of time; (b) that the more succulent, tender raw vegetables with a higher sugar content might cause a more rapid build-up of bacteria on the equipment in the packing line.

Larkin, Litsky and Fuller reported isolation of colon bacilli and fecal streptococci from many samples of commercially frozen fruits, fruit juice concentrates, and vegetables *(6)*. *Escherichia coli* decreased in numbers over a storage period of 200 days at 0° F.; whereas the numbers of fecal streptococci remained constant. Phosphate buffered suspensions of *Streptococcus faecalis* were shown to be susceptible to destruction by chemical sanitizing agents but an attempt to decontaminate fresh green beans with roccal, chlorine or iodine was without effect. Hot water at 88° C. for 1 minute was effective in destroying the test organism.

Larkin, Litsky and Fuller studied frozen fish *(7)*. They advocated the use of fecal streptococci as a test organism for the bacteriological examinations of frozen fish products. They suggested that the breading procedures after cooking may represent a source of fecal contamination.

Although extreme care by the food processor may result in an excellent product with a bacterial count that may pass any high standard, all effort is wasted if the product is mishandled before its consumption. When frozen citrus juices were first marketed, oftentimes they were left unrefrigerated in the receiving rooms of retail stores; sometimes for hours or days at room temperature.

An example which recently came to the author's attention involved 10 hams which were cooked until the

internal temperature reached 165° F., after which they were sliced and handled by a butcher who had a severe facial acne. The sliced hams were stacked in 2 trays covered with aluminum foil and kept at a warm temperature for 7 to 10 hours before serving. At the time of slicing, the ham was eaten by several people who remained well, although those eating it 7 to 10 hours later became acutely ill. The strain from the acne lesion and that recovered from the sliced ham were found by bacteriophage typing identical.

Then, there is the case of a laboratory worker who upon occasions when he worked late would purchase frozen meals and place them in the incubator to thaw and warm before eating. In my opinion, handling of frozen foods in this manner invites illness to the consumer.

Many perishable frozen foods are handled by one or more people during preparation and then are frozen without further heat treatment. However, the processor specifically recommends cooking at a time and temperature which is calculated to destroy pathogenic microorganisms. Sometimes these directions are not heeded by consumers, or again, stove temperature regulators may be absent or inaccurate and under such circumstances pathogenic microorganisms may survive cooking. Thus, a product meeting an initially high microbiological standard can spread illness.

Laboratory procedures for the detection of some pathogenic microorganisms in food have not been standardized and it is doubtful if we have enough data and information to formulate microbiological standards for many of our food items. As sanitation improves and as more effort is expended in attempting to find the source of possible food borne illness, occasionally a food source is discovered. Such cases are usually thoroughly investigated and sometimes a problem arises which may involve a whole class of foods. These experiences although distressing when they occur, usually result in better plant sanitation, in uncovering defective equipment which allows growth of pathogenic or spoilage microorganisms, and in introducing better operation and changes in processing which sometimes prove a boon to an entire industry.

Microbiological standards are often established in progressive food companies as a measurement for the quality of the product. These standards serve many useful purposes and play an important role in the economy of operation. Where sound scientific knowledge is available and in foods where standards are feasible and practicable they should be established and used.

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Quartermaster Subsistence Training Keeps Pace with Food Industry Advances[a]

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(Manuscript received June 5, 1956)

As food technologists and perhaps also as veterans of the Services, you will doubtless be interested in knowing that the Army has a training activity where officers with food responsibilities can gain a sound perspective on this business of 'feeding an Army.' My purpose today is to present the nature and scope of this program, not in generalities but in its concrete details. I believe that more people should be acquainted with the fact that subsistence training today concerns itself with the modern industry and a modern Army.

The Quartermaster Subsistence School is an Army Specialist School located in the City of Chicago. It is under the jurisdiction of The Quartermaster General, Department of the Army, and operates as an integral activity of the Quartermaster Training Command. Originally established to train officer personnel for the various subsistence activities of the Quartermaster Corps, the Quartermaster Subsistence School today trains officers of the Army, as well as the Navy, Air Force, Marine Corps, and allied nations in the practical aspects of food technology. An officer so trained must be familiar with basic food items and be able to assist in the planning and coordination of the procurement, storage, and distribution of subsistence for the military forces in the continental United States or overseas. To fulfill such an assigned duty, the officer must know quality standards, market prices, sources of supply and practices used in the marketing of subsistence items both perishable and non-perishable. The training is accomplished by following a well-developed program of classroom instruction and by the cooperation of the food and related industries who furnish either guest instruction or the facilities of their plants for field trips.

Training keeps pace with industrial progress. The program of instruction and the duration of the course have been changed from time to time in order to reflect the type of instruction required by current and

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 13, 1956.

anticipated changes in food logistics and to permit the school to carry out its assigned military mission. One of the major activities of the individual instructor on the faculty is to keep abreast of industrial changes and modifications through industry visits, study of trade publications, published research papers, and through conferences with industry representatives. The food industry is progressive. The subject matter of Quartermaster subsistence training keeps pace with industrial progress and delineates accepted industrial concepts.

The current program of instruction for the Subsistence Technology Course consists of 833 academic hours presented during a period of 24 weeks. The course is divided into fourteen subjects, which are:

Dairy Products, Poultry and Eggs
Meat, Meat Products and Waterfoods
Cereals and Cereal Products
Fresh and Processed Fruits and Vegetables

General Products
Operational Rations
Science of Food Technology
Food Packaging and Packing
Nutrition and Food Service

Subsistence Staff Writing
Subsistence Marketing
Comptrollership and Subsistence Funding
Subsistence Procurement
Subsistence Logistics

The first five of these academic subjects pertain to the technology and military aspects of the basic food commodities. The instruction in these commodity courses includes discussion of the various industries—their history and development, their present organization and structure, production and supply areas, commercial practices and problems. Each product or item is studied with respect to its identification and classification, production and processing techniques, inspection procedures, quality control, commonly used methods of packing and shipping, and the latest developments that may influence their use by the military services. These five commodity courses account for over one-half of the number of hours in the program of instruction.

The remaining hours are devoted to the subject areas related to either the product itself or to the logistics of subsistence. At the beginning the student receives an introductory course into the terminology of food chemistry as well as a review of basic chemistry and microbiology. Other courses are then integrated into the program and these include: *Procurement* — which teaches the student the principles and operational procedures for procurement of subsistence for the Armed Forces; *Subsistence Logistics*—which deals with the procedures for the receipt, storage and distribution of the items procured and includes a study of the agencies which make up the military supply chain; *Nutrition and Food Service*—which provides the student with an understanding of the nutrients, nutritional requirements, and the aims and responsibilities of the Army Food Service Program; *Food Packaging and Packing*—which is a study of the container industries and their products insofar as is necessary for an understanding of packaging techniques and their application to the procurement of military subsistence; *Operational Rations*—wherein those rations which are designed primarily for field use are studied, including their development, characteristics, the problems encountered in procurement, and their effective use in feeding under combat conditions; *Subsistence Marketing*—which is primarily a study of the agricultural marketing system of the United States; *Comptrollership and Subsistence Funding*—which is the course where budgeting, distribution, authorization and management of funds used for subsistence procurement are thoroughly covered. Finally, a review course in *Staff Writing* is presented. With this intensified program of instruction, an officer is given the basic knowledge necessary for performance of duty in the subsistence field and as a basis for further study.

Full-spectrum education offered. Instruction in the school is conducted on the lecture-conference basis, augmented by guest speakers from industry and from Governmental agencies, by practical demonstrations and exercises and by field trips. Location of the school in the Chicago area provides us with the opportunity of receiving not only the assistance of experienced representatives of a unique cross section of the food industry but also immediate information on the latest advances in subsistence research and development being performed by personnel of the Quartermaster Food and Container Institute. The Institute supplies guest speakers and demonstrations on such late developments as the preservation of food by radiation, the technology of canned bread and other canned baked items for operational rations, and on research advances in the area of quick-serve foods such as dehydrated or quick frozen meals. The Quartermaster Market Center System, with headquarters in Chicago, provides current information on their procedures and on any revisions in the procurement or distribution of subsistence. The Department of Agriculture lends assistance through guest speakers who present inspection procedures and demonstrate techniques of grading as well as providing the latest agricultural marketing trends. To supplement the training even further, field trips are made to various food processing plants within the Chicago area. The school is deeply indebted to the members of the food and related industries who open their plants and who expend a great deal of time and energy in making these trips a success. Realizing that the students have been studying the process and will ask many technical questions, the plant management uses care in selecting guides to take the groups through the plant.

Through the medium of these trips, the student is given the industrial side of the picture with special reference to the unit operations of food manufacture. With the help of industry we are able to make the training of subsistence personnel realistic and abreast of commercial practices and advances.

Here are a few representative examples of the field trips conducted by the school. Under the subject, Cereals and Cereal Products, the student is taught the technology involved in the production of all cereal grains used in the manufacture of food products procured by the Armed Forces. One element of this course

deals specifically with the commercial manufacture of cookies and crackers, including both the commercial types and those developed for military use under field conditions. In the classroom prior to the field trip, the student learns the ingredients used, the methods of manufacture and equipment required for production, the problems involved in packing and storing, and the Federal specifications pertaining to these items. Following the classroom presentation, a trip is made to a plant engaged in production of crackers. The unloading of flour from specially constructed freight cars by an electronically controlled pneumatic system and its storage in large bins is observed. An explanation is given of the subsequent movements of flour and other ingredients through sifters and automatic batch making machines to mixers. Operation of the large rotary or sheet cutters and the continuous process of baking follows. The demonstration is concluded with an explanation of the various types of special packaging employed and which are necessary to preserve the freshness of the products. Here the student sees the modern techniques of baking and mass production being applied as well as how the manufacturer maintains quality control.

In the study of Dairy Products, the student is grounded, for example, in the subject of cheese and his instruction is then supplemented by a trip to a large processing plant whose design materially aids the instructor in his teaching. Competent personnel act as guides to give reliable and valid information about the procedures observed. The student observes the procedures involved in the storage of bulk cheese in this modern plant—how the cheese is selected by a man apt in the perception of flavor and body of cheese, how the cheese is set up into batches that will produce a processed product that has flavor and body characteristics that are uniform from day to day and week to week. The further steps in processing are clearly demonstrated to include the final packaging of the products. Here the students see the relatively new techniques of packaging sliced cheese under aseptic conditions. When the tour of the plant is completed, the supervisory personnel meet with the students to answer questions, further explain the processes, or to discuss the problems involved in the production of cheese and cheese products including possible impacts on military handling and storage.

Throughout the subcourse on Meat, Meat Products and Waterfoods, each of the meat animals is discussed in class and the various meat packing operations are then observed in the large packing plants in the Chicago area. Carcasses of beef, veal, and lamb are studied to see the variations in quality by actual grading of mixed lots of display carcasses. One full-day field trip is devoted to pork operations, following the live hog through slaughtering, carcass breakdown, division of cuts into fresh, cured and smoked products. The methods of curing are observed which include dry salt curing, dry box curing, and pickle curing.

The students learn also the different methods of injecting pickle into the meat. The recently developed techniques of stitch pumping slab bacon, and mechanically controlled arterial pumping of hams are explained. Further, the students are shown the latest smoking processes and the thermostatically-controlled air conditioned smoke houses used in modern plants. Many processes and products of the meat industry are constantly being developed which may be advantageous to the military services.

Figure 1. Demonstrating the cutting operations involved in prefabricating boneless beef.

The procedures used and the advances being made in the technology of Fruits and Vegetables are thoroughly brought out by various field trips during this phase of instruction. The individual items of fresh fruits and vegetables are exhibited during the classroom hours. Then the student is taken on a tour of a large wholesale fruit and vegetable market. Here he observes the latest developments in container and protective packaging, together with the methods used in the receipt, display, storage and delivery of these products by the industry. The traditions of the trade and terminology used are noted and explained by Market Center "sight buyers," who act as guides. Another phase of the Fruits and Vegetables Course includes the study of processing pickles. Following the classroom instruction, the students are taken to a manufacturer's plant. At the plant they see how chemistry and bacteriology play an important part in processing pickles. Through good quality control the manufacturer has been able to standardize the various types of pickles from batch to batch. They see how machines sort cucumbers into proper sizes for further processing, the use of the continuous cooker, and how sweet relish is packed into various sized containers by automatic filling machines. Actually seeing these and other operations provides the student with first-hand knowledge of this phase of the food industry.

Constant supply of trained subsistence officers. The Quartermaster Subsistence School, through its graduates, furnishes to the military a supply of officers trained in the practical aspects of food technology and in the storage, distribution and procurement of subsistence. This training assists them, in no small measure, to perform their part in the task of feeding the military forces. Military subsistence operations are wide and complex and a concise course in the characteristics of the various commodities, the unit operations involved in their processing, and the management aspects such as procurement, inspection, and distribution provides the subsistence officer with a perspective on his particular assignment. Experience in the field can be expected to round out his training.

Motivations for Department of Defense Research on Rations*

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Quartermaster Food and Container Institute for the Armed Forces, Chicago

(Manuscript received June 28, 1956)

OF THE NATION'S total food supply a sizeable percentage is consumed by the Armed Forces. Probably from six to eight million meals per day are being consumed by the men and women in our military forces. Projected further, this amounts to three billion meals a year. In World War II, these figures were about three times higher—that is, 24,000,000 meals were consumed each day and better than 8 billion meals per year.

It is of great practical importance to consider these impressive figures in terms of the technical problems they represent. One set of problems can be immediately visualized. A meal is normally made up of a meat or fish entree, vegetables, breadstuffs, a dessert, and a beverage. Each of these items presents problems inherent in the product itself. Considering the amount of food—and therefore money—involved, it can be taken for granted that the Armed Forces should be aware of and should apply every useful advance made by the cereal chemists, the bacteriologists, the biochemists, the food technologists, the nutritionists—in fact, all food scientists. Food, its keeping quality, its palatability, and its nutritional adequacy have a direct effect on the operational efficiency of our servicemen. Food is also a part of the serviceman's pay, and he has a right to expect good quality and adequate quantity.

Another set of problems concerns utility. Knowing that military foods will be distributed on a global scale and be consumed by land, sea, and air forces, it is the obligation of the Armed Forces to assure the adaptability of that food to use in definite operational systems. This is something we can grant without debate. It is basic to the whole business of effective defense. Our Armed Forces must be superior to any possible enemy in ability to maneuver swiftly and to sustain their flexibility in combat operations for one day or 10 or 100. This means that food—like any other fuel—must be ready to hand and ready to go at all times. This is practical common sense and easy to accept, but what may be more difficult for some people to agree with is that there is anything sharply different in military feeding problems from those encountered in any other type of large group feeding. It is easy to forget in time of peace the extreme conditions encountered in military operations. One of the important purposes of this paper will be to define some of these differences and to explain their origin. My comments will be useful, I trust, as background for the excellent papers on special problems of military concern that will follow.

Special purpose rations. Not all of the millions of meals just referred to are eaten in garrison where everything from refrigerator to range to dining table can be nicely controlled. A sizeable number of those meals are packaged meals designed for use by servicemen engaged in a particular type of military assignment, remote, in most instances, from kitchens and dining facilities. Examples would be when, during flight, an air crew is supplied with precooked frozen meals—carefully designed as to menu to meet certain physiological requirements peculiar to flight and also to meet utility requirements. In areas of extreme low temperature, another type of portable meal is supplied—a special operational ration called the Ration, Individual, Frigid Trail. There are many other special rations, all of them described in the booklet, *Current Operational Rations (1)*.

It will be instructive to consider for a moment the background factors that led to the development of the Frigid Trail Ration. They are quite different from the factors that inspired the precooked frozen meal and still more different from those considered by the food industry whenever a new idea for a food product emerges. In connection with studying the problems of men, equipment, and environment in the Arctic, the Armed Forces saw the need for a stable, palatable ration high in calories that could be consumed in the face of an arctic gale, if need be, with cumbersome gloves and face protection impeding the eating process. The research and development required to design, to prototype, and to bring this ration through all the tests—acceptance, production, user tests—was guided, at every turn, by the need to integrate the ration with Arctic equipment, modes of transport, the climate, and even the soldier's attitude toward his assignment. Ration, Frigid Trail, could never be a popular item on the shelf of the grocer. Industry could not afford to spend time and effort on a food that is designed to be integrated into a particular system of human activities in a specific climatic area, and with no assured turnover. The Armed Forces, on the other hand, could not afford *not* to do so, for such projects are essential to national security. More particularly, they are essential to the security of men who might one day—in actual combat—be under severe stress, fighting the cold and the enemy with "queasy" stomachs. Men in action may not be very hungry but they nevertheless must eat. If soldiers in combat do not eat, physical exhaustion follows quickly. And you cannot win battles in the Arctic or anywhere else with physically exhausted men.

The serviceman—whether he is a soldier, sailor, or airman—is a unique type of consumer. In the first place he is under stress, and his environment, his equipment, and his subsistence interact to affect his psychology (Figure 1). These problems of environmental stress are under study *(2)* and progress is being made in alleviating stress through the development of rations, clothing, and equipment that will help to nullify stress. Stress problems are as varied as the geographical

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Figure 1. Korean conflict: Men of Co. B, 17th RCT, 7th Division, take cover behind a stone wall during action northeast of Kumma-ri.

and climatic areas in which he may find himself and as varied, also, as the kinds of military operations that go into the functioning of a military machine *(3)*. In today's warfare, operations on land, at sea, and in the air are highly coordinated, and the interrelationships of these problems must be considered.

Because of these specialized problems of the military consumer, it is always necessary for military research and development to be abreast of industry and institutional research progress. On occasion it is advisable and necessary for us to take the lead, without waiting for industry and institutional research, in attacking a problem. Radiation preservation of foods falls into the latter category, and in another session you will be able to learn of the technical progress being made in that program. In this session, I might mention, there is included one paper on radiation preservation. The reason for its inclusion is that, pinpointed in this particular report on progress, are unmistakable implications of the military usefulness of foods processed by this comparatively new method.

I shall not anticipate what is to be said in that paper, but I would like to use it to exemplify another difference between military and commercial objectives in food research and development. The Armed Forces are relying on foods preserved by radiation to offer, among other advantages, an alternate food resource in the event of atomic warfare. You are all familiar with the fact that one of the principles of Armed Forces procurement is to have a diversity of supply resources. That is one of the reasons why industrial mobilization exists. Radiation processed foods should reduce the burden on other modes of food preservation and increase as well the variety of foods available for use in combat zones. We are also anticipating that radiation treated foods will fulfill that desire for freshness of taste and texture. In Korea we partially achieved this goal the hard way—by producing fresh produce by hydroponic farms in Japan and flying it in.

Thus far, I have been speaking in terms of motivation—why Department of Defense food research is essential to security and what, with a few concrete examples, we are doing that specifically bears on that point. Our security today is important, but our security tomorrow is even more important. For this reason I would like to spend the remaining time pointing out in simple language the places where military food research and development can benefit anticipated ration needs of the future.

Anticipating tomorrow's ration needs. It will come as no surprise to any of you, I am sure, that the term "atomic warfare" has come into common use. Logistical and strategic methods have been undergoing drastic revision. Increased attention is being given to the coordination of all elements of defense in order to attain the ultimate in the simplification of supply systems, greater economy in the use of our combat forces plus increased speed and maneuverability. The nuclear bomb has given us—and the unfriendly powers—massive striking power. All of this means that there has come upon us the paramount requirement that supplies must not be conspicuous and that our forces must be held in comparatively small, dispersed groups capable of quick tactical shifts away from one area and into another.

Against this rigid set of requirements we can immediately see one important impact on rations. Well equipped, stabilized food storages, kitchens, and messing facilities can no longer be considered feasible—neither within the zone of combat nor in the immediate supporting area. Such a setup would furnish too attractive a target. Existing rations will probably continue to serve special purposes but research and development has now turned to new feeding concepts and new rations—such as the so-called dehydrated, precooked, complete meal. This will be available as an individual meal. Guidelines in the development of such a meal are the requirements imposed by the grouping of men, their equipment, and by the attributes of the military environment in which, at some future date, men are likely to find themselves. It is obvious that, with a dehydrated meal, the availability of water for reconstitution will be of paramount concern. In some areas of the world this could be a real problem. Also, since hot meals are known to be well nigh indispensable to both morale and physical well being, the availability of heat sources is another vital factor in the design of rations for the future. There is plenty of room here for continued research.

Naturally, the science of feeding men under atomic warfare conditions is far from being codified and established. Obviously it can progress no faster than the parent subject matter permits—i.e., the strategic, tactical, and logistical patterns being evolved for future defense. The food phases of logistics now being worked upon are (1) methods of feeding, (2) the components and the menus for the proposed meal, and (3) food equipment requirements.

You can see that our program for the future is a challenging one, and that many groups within the Department of Defense are and will be participating in it. In concluding these remarks I would like to stress the fact that the revision of our ration systems to meet the

anticipated requirements of atomic warfare will place more rather than less responsibility on our food chemists, bacteriologists, nutritionists, food technologists and packaging engineers. New areas for the coordination of food research among the Services are also involved, and certainly to be expected is an intensification of subsistence training. It will not be necessary, however, to expand my remarks since the papers to follow will inform you of current projects and progress in these various phases of food research studies within the Department of Defense.

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New Objectives in Feeding Our Fighting Forces[a]

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THE ARMED FORCES have new objectives. They arise out of the "ashes," if I may call them so, of the first two nuclear bombs.

Perhaps I should explain why this is so.

Consider, if you will, the time-honored principles of supply as they existed "before the bomb." These supply lines began at scores of points of origin and ended at the main lines of resistance. Along those lines were innumerable specialized service and communications agencies linking up transportation, storage, reshipment functions—and handling the countless routine and emergency requests that governed the flow of supplies. The "Man from Mars" looking down on this network of rail, water, and (more recently) air traffic doubtless found little that made sense in this busy scene—with people, and ships and trains and planes, and orders (and perhaps rescinded orders) flowing haltingly along, *to* and sometimes *fro*. But the system did make sense—before the nuclear bomb. It made sense in Korea, where, fortunately, no bombs of the nuclear type were dropped (Figure 1).

One trouble with this system in today's world, as General Gavin has ably pointed out, is that the old concepts of linear supply, with tempting targets all along the way, doubles the task of defense; namely, defending position *and* defending concentrations of supply. Food research and development at the Quartermaster Food and Container Institute for the Armed Forces contributes to the prevention of such concentrations.

New thinking in regard to supply visualizes bases of supply, i.e., large concentrations of materiel, well out of range of atomic mass destruction, with smaller depots (or piles in some cases) of re-supply as required. The new supply pattern, because of the fact that planes are free to operate in three dimensions, can take any form required. Thus, though fighter protection will still be needed, it can be applied more effectively, and with dispersed targets, losses will be minimized. If necessary, in any emergency, the supply pattern can literally be changed in midair, making it yet harder for the enemy to find a profitable target. Under this system, also, supplies destined for one region can be deflected to another more critical region when desirable.

Figure 1. Motor pool area of the 7th Qm Company, "the eightball express" 7th Infantry Division, showing trucks laden with clothing, fuel, food, and equipment at the start of a convoy run.

Although the foregoing explanation is highly generalized—and perhaps well known—the effect of this new pattern of supply on military feeding will be tremendous, particularly so since the points of delivery for foods will probably be more or less isolated battle groups always ready to move in any direction—afoot, by ground vehicle, or by air. Chief impact on food supply will be that food must be functional in the Nth degree. Weight must be low, cube must be minimum, speed of preparation and consumption must be maximum. But above all, rations must fit into the whole complex of systems that govern the operations of combat and support forces under atomic warfare conditions.

New objectives. New objectives are therefore best defined in terms of (1) equipment, (2) feeding methods,

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and (3) the ration and its components. Let us pause briefly on the first of these—equipment. Perhaps the basic emphasis as it relates to new food equipment will be on the development of collapsible equipment—and already a collapsible range is being worked out. Multiple-use characteristics are also being given renewed attention—a food package, for example, that can double as a food-service device. Research effort is of course being expended on much more comprehensive food preparation equipment, but this is not the time to go into these matters.

A second objective is the development of feeding methods. The problem is a difficult one; namely, how to get food—hot, if possible—from a food sanctuary out of range of the bombs to little patches of well-dispersed battle groups. An easily transported packaged meal, held hot over the distance of transport trips—or easily reheated if it arrives cold—is a possible answer, and possibly the only answer. The question still remains—how to do it?

There is some real logistical algebra connected with this problem. The soldier even after he has his ration delivered will probably have to carry it for a time. The marching load of a soldier cannot exceed 55 pounds—actually, it has been found that 45 pounds is the limit in combat. The battle-load part of this 45 pounds—weapons, etc.—is calculated at 25 pounds. The so-called "existence" part is 20 pounds. From this 20 pounds, the weight of nonfood items—medical aid kit, toilet articles, trenching tool, water—must be subtracted. With the pressure on to increase mobility and flexibility in the "new army" it is easy to see where the demand for less and less weight is going to hit hardest. No matter how the soldier travels he will always have to handle and carry everything he uses himself. He, the soldier, is therefore likely to be the first to want reduced weight in rations. Being an American soldier he will be able to make his wants, in this regard, known. These brief comments will perhaps serve as a backdrop to my concluding comments; namely, what are our objectives regarding the ration itself?

First objective, perhaps, is to attain palatable, easily prepared food that can be bounced around without suffering too much damage—you will recall that air transport, including the possibility of air drop, is involved. It is plain to see that concentrated or completely dehydrated precooked foods are needed to implement this objective (Figure 2). If any other forms of preserved foods are supplied it will certainly be necessary to leave every ounce—perhaps I should say every gram—of the nonedible portion at the point of manufacture. As to our progress on this compact, ready-to-eat meal, it is possible to say that item by item the menus are being composed. Perhaps the item most interesting at present is dehydrated meat, a development of the industries and the colleges, but one that the Institute can lay claim to having helped along with a continuous and lively interest. Dehydrated fish sticks are also eligible components of the proposed ration.

Packaging the completely dehydrated precooked individual meal is also an extremely difficult problem. A number of concepts are being entertained—for example, compartmentizing the container to permit reconstitution of the dehydrated foods by the simple operation of pouring hot water into the individual compartments. The complete, compartmented container would thus be its own "cooker." This is an ingenious idea, and it can probably be worked out by our packaging and applications engineering group. But it will have to be relatively inexpensive to make since present thinking calls for a readily disposable container. A reusable container of rigid construction would offer advantages in easy preparation of food, but weight and the problem of dishwashing must immediately be entered on the "disadvantages" side of the ledger.

Figure 2. The precooked dehydrated meal for small group feeding. Components include: 1. chili and beans, 2. instant rice, 3. fruit mix, 4. bread, 5. soda crackers, 6. margarine, 7. jam, 8. cookies, 9. instant cocoa beverage, 10, 11, 12. accessories, 13. stirring spoon, 14. shipping case.

No group can walk alone. In concluding my comments I would like to emphasize that our adoption of new objectives does not mean that we have abandoned all of our old ones. At the Institute we are still interested in and working upon better ways to preserve foods, to retain the nutritive qualities of packaged foods, and to learn more about what foods the Serviceman likes, how much he likes it, and what stresses, within himself or his environment, do to his attitude toward food. In all of our research and development objectives, we derive great profit from our close association with food technologists. In the technical world of today no group can walk alone. We in the military phase of food research cannot afford to walk alone since our sustained objective—one that takes precedence over all others—is to assure that in regard to foods and containers our Nation will be prepared for any possible emergency.

Influence of Radiation Preservation of Foods on Military Feeding[a]

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IT IS MY INTENT to indicate some of the pertinent facets of radiation effects as they pertain to food preservation and the potential impact of the employment of this technique upon the systems of food service as we presently know them in the Armed Services, particularly during combat in overseas theaters.

Overseas feeding problems—a case study. To create an appropriate mental attitude for this discussion, let us retrogress to July 1950 at the time of the onset of the Korean hostility. Let us consider briefly some of the pressures, requirements, and objectives that give direction and purpose to the course of action followed by a subsistence officer. In particular, the Subsistence Officer of the Eighth Army—at that time Colonel W. D. Jackson, QMC, presently Chief, Office of Research and Development, Office of The Quartermaster General.

Clearly the first requirement was to mount out divisions stationed in Japan for immediate battle in Korea. Since we are here concerned exclusively with the feeding problem, the concomitant requirement was to feed them.

Under the conditions imposed at that time, it was necessary to rely entirely on non-perishable food items. Therefore, the men were fed C-rations and B-rations. The C-ration is limited to six menus, the essential difference being in the meat item. There are six separate menus containing some twelve meat or meat type elements. The B-ration is composed of 15 separate menus, which are repeated twice a month. Within these menus there are 9 canned meats including bacon and the old standby spam. In these menus there are a number of repetitions of the basic meat items—Corned Beef, 6 times; Beef with Gravy, 10 times; Ham Chunks, 18 times; Chicken; Chili; Ground Beef, 8 times respectively—though the method of preparation and presentation may be different. In the early days of the fighting, our troops had to be satisfied with these items. Facilities for refrigerated distribution to and within Korea were practically non-existent. The lack of such facilities will continue to plague our Army in the field whenever it is fast moving and widely dispersed, two fundamental concepts of modern warfare. If, as appears to be the case, air transport is to be an important supply medium for both men and machines in future conflicts, then the problems related to refrigerated distribution are magnified since such equipment is extremely heavy and bulky, and it appears most unlikely that it would be built into aircraft.

To continue reporting the situation that existed in Korea in the first months of the war. While a portable bread bakery was being constructed in Pusan, an effort was made to ship fresh bread from Moji on the Island of Kyushu. The ferry took twelve hours to go from Moji to Pusan and then an additional 36 hours were required for bread to reach the front. July happens to be the rainy season; the weather was hot and humid. All the bread arrived at its destination covered with mold. In an attempt to salvage the operation, the bread was cooked longer, the formula was adjusted—all to no avail—the mold spores won out. It was necessary to stop shipping bread. An effort was then made to substitute locally prepared biscuits, but with the limited oven space and large requirement for baking powder, it was not possible to meet the demand.

Following on the heels of the bread problem, field commanders began to report that the canned meats were soft, tasteless, and monotonous. By August, sufficient transport had arrived from the States to permit the diversion of two small ships each with about 1000 tons of refrigeration space. These ships were loaded with frozen boneless beef in Japan and dispatched to Korea. The problems of distributing the meat forward to the troops after it had been unloaded from the reefer ships was so great and the losses so high the operation was stopped. Thus the troops in Korea continued eating canned operational rations and were complaining.

Experiments were conducted with air delivery of perishables from hydroponic farms in Japan. It was possible to lift limited quantities of tomatoes, green onions, radishes, cucumbers and lettuce, without refrigeration. These items were received enthusiastically by the troops. Yet it was an extremely limited success because the growing season soon ended, and because of difficulties in the distribution system within Korea, only limited numbers of troops in the combat area received them.

By 10 November all the perishables for the Thanksgiving meal were on board ships in Japan moving to the ports in Korea. This coincided with the Chinese offensive and required considerable rerouting in order to get the items to the troops.

It was possible with the combined efforts of the Navy's ships, the Air Force's planes, and great numbers of Army trucks and rail facilities to get by the 26th of December a Christmas dinner to every soldier. The effort needed to accomplish this feat is beyond imagination—the effect on the morale of the troops was equally great.

By mid January utilizing all means available some perishable shipments were beginning to move into the distribution system to relieve the monotony of the canned B-ration diet. As the war stabilized along the 38th parallel, refrigerated trucks and rail cars arrived and perishable shipments gradually increased until it was again possible to claim that U. S. soldiers were the best fed soldiers in any war.

It is readily apparent from the foregoing that many problems still exist within the military systems for supplying foodstuffs to troops, particularly in combat

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areas. Just as there are many problems there are many possible solutions. Some possible solutions can be readily discarded because of their obvious impracticality, excessive cost, or lack of sufficient knowledge to work out their feasibility.

Five prerequisites must be satisfied. This done the problem is still far from solved because a system by which the new solution can be applied is necessary. Equally trying—any new system for accomplishing a single mission must be compatible with the entire series of systems for troop utilization. However, two techniques of food processing suggest themselves as providing potential answers to most of the difficulties inherent in the feeding situation outlined earlier. Both are under intensive investigation at the Quartermaster Food and Container Institute. The first of these is dehydration, the second is radiation by gamma or beta rays. For this particular discussion let us limit our consideration to radiation only. There are five prerequisites that the radiation processing of food must satisfy:

1. The treatment must in fact kill the bacteria, parasites, insects and other contaminating entities present in food.
2. The irradiated food must not be toxic to man.
3. The treatment must not adversely affect the taste, odor, texture and appearance of foods.
4. The foods so processed must be stable in storage.
5. The process must be economically practicable.

Let us quickly review the situation regarding these requirements.

Control related to dosages. It can be categorically stated that all life can be destroyed provided a sufficiently high dosage is applied. In general, the following orders of dosage apply:

1. At 12,000 rep: sprouting of potatoes and onions is inhibited.
2. At 30,000 rep: trichina, and other insects are killed.
3. At 200,000 rep: most micro organisms are killed (pasteurization).
4. At 3,000,000 rep: The most resistant of bacteria are killed (sterilization).

Thus concerning point one, research on this new type of processing is on a firm basis.

Non-toxicity. Though a most conservative approach and attitude is being employed in evaluating the lack of toxicity and retention of wholesomeness of foods preserved by radiation, it is possible to report the following conclusions:

1. No radioactivity is induced in foods as a result of beta or gamma radiations, at the energy levels required for sterilization.

2. To date, no evidence has been uncovered to indicate that radiated foods are not wholesome. Extensive and intensive animal studies have been conducted in many laboratories; all studies have supported each other. Even more important than the animal studies are the human feeding studies which have been conducted by The Surgeon General, Department of the Army, at Medical Nutrition Laboratory during the last year. In these studies, the levels of radiated food intake have been 35, 65, 85, and 100% respectively of the total calories consumed. A report published by McGary and Bernstein in the *Journal of American Dietetic Association*, Volume 32, dated February 1956, summarizing the first two studies, reports no untoward effects. The last two studies are completed and though no report has been published it can be reported that again no untoward effects were noted.

3. There is some destruction of certain of the vitamins. The order of magnitude of vitamin loss is comparable to the losses occasioned by heat processing, i.e.

TABLE 1

Retention of vitamins in meat

Treatment	Niacin	Riboflavin	Thiamine	Vitamin E
3,000,000 rep	84	72	12	60
2½ lb. can heated 146 min. 235° F.	80	76	52	...

It bears repeating that losses in vitamins or any other specific micro nutrient is not to be considered synonymous with toxicity.

Acceptability. The taste, odor, texture and appearance of different foods vary when the foods are radiated. The thresholds at which effects are produced are vastly separated. Milk develops undesirable off-flavors at 100,000 rep while dried prunes show no undesirable effects at 3×10^6 rep. At doses of the order of 30,000 only a very few foods are adversely affected. At pasteurizing doses (200,000 rep) foods such as bananas, crab meat, oranges, strawberries, butter, milk and cheese are adversely affected while luncheon meat, pork, ham, carrots, coleslaw, spinach, peas, and mackerel, remain most acceptable. At sterilization doses, quite a few foods remain most acceptable, having either no detectable changes or those of such minor nature that there is reason to believe that they can be engineered out of the product with continued study. Examples are: asparagus, bacon, veal, liver, broccoli, chicken, Cornish hen, guinea hen, codfish, oysters, clams, applesauce, pears, peaches, green beans, codfish cakes, corned beef, halibut, shrimp, perch, ham, pork, tenderloin of pork, pork sausage, sweet potato and waffles. There are other foods in which much more work is required before they can be sterilized without producing undesirable flavors and odors. Such products are beef, lamb, mackerel, cabbage, and frankfurters.

There is a considerable mass of data concerning the acceptability of radiation processed foods as evaluated by differing taste test techniques. Some of the results are in conflict though generally there is good agreement. The only situation where general human consumption has existed has been at Medical Nutrition Laboratory. The results of the acceptability evaluations are shown in Table 2. The data are reproduced from the article, "Acceptability of Irradiated Foods" (McGary, Shipman and Bernstein, *J. Am. Dietet. Assoc.*, February 1956).

Stability. It is not enough to produce a product that is sterile, wholesome, and acceptable in terms of color,

TABLE 2
Average relative acceptability of control and irradiated food items

	1 Like extremely	2 Like very much	3 Like moderately	4 Like slightly	5 Neither like nor dislike	6 Dislike slightly	7 Dislike moderately	8 Dislike very much	9 Dislike extremely
Beef, ground				C R					
Ham, ground					C R				
Bacon, ground			C R						
Haddock					R	C			
Peaches			C R						
Strawberries				C	R				
Green beans					C	R			
Beets						C	R		
Cereal bar				C R					
Bread				C R					
Milk, powdered				C	R				
Tenderloin steak				C R		R			
Ham steak			C	R					
Corn, whole kernel					C	R			
Bacon, sliced			C R						

Legend: C = control; R = irradiated.
From *J. Am. Dietet. Assoc., 32,* 125 (1956) by permission.
Acceptability was rated on the 9-point hedonic scale, ranging from *like extremely* to *dislike extremely*, as used by the Quartermaster Food and Container Institute for the Armed Forces.
Nine subjects were used.

odor, taste and texture. This product must, in order to satisfy most military characteristics, possess a high degree of stability in storage. The greater the storage life without deterioration, the more useful the product. In this matter of stability there is a general question pertinent to radiation processing which is still unanswered. This is the question of enzyme inactivation. Enzymes are not inactivated at 3,000,000 rep which is a reasonable sterilization dose. Some enzymes are resistant to doses as high as 10,000,000 rep. It would appear from very limited data that products in which enzymes are not inactivated either immediately before or after radiation show signs of enzymic degradation. In meats, for instance, there is a remarkable increase in the free amino acid content of non-enzyme-inactivated radiated products stored at 72° when compared to similarly treated products in which enzymes have been inactivated by partial cook prior to radiation. The occurrence of this autolysis may not be an undesirable feature, particularly if it produces a more tender meat or sweeter fruit. The principal problem is whether or not these degradative changes go on at such a rapid rate that undesirable attributes are developed before a reasonable anticipated storage period is fulfilled. Sufficient data is not available at this time to justify a definite conclusion. However, if it develops that enzyme inactivation is necessary, techniques for doing this are well known and not difficult to apply.

Cost of Radiation. At this time it is not possible to quote any hard and fast figure for cost of sprout inhibition, disinfestation, pasteurization or sterilization produced by radiation. The following table gives some estimate of the range of costs calculated from the average cost of radiation service at the several sources presently utilized by the Department of Defense program. These are gamma facility Material Testing Reactor, Arco, Idaho; gamma radiation facility at Dugway Proving Ground, Salt Lake, Utah; gamma radiation facility at Argonne National Lab., Chicago, Illinois; and several Beta ray sources such as High Voltage Engineering in Boston, General Electric in Milwaukee, and Applied Radiation Corporation of Walnut Creek, California:

TABLE 3
Costs as calculated from average radiation service charges

For sprout inhibition	14 cents to $5.00 per ton
For grain disinfestation	10 cents to $1.00 per ton
For meat sterilization	3 cents to 7 cents per pound

A study completed by the Oak Ridge School of Reactor Technology indicates that a heterogeneous reactor of 7-megawatt capacity could process more than 1000 tons per month at an average cost of approximately 2.9 cents per pound.

Improved acceptability promised for irradiated ration items. The cost of the food item and its processing is of concern to the Military Establishment; yet, this consideration is generally secondary to two other facets of military feeding. As indicated in the opening remarks, the fact that the requirement for troops to be subsisted on heat-processed canned rations for an appreciable period of time results in dissatisfaction cannot be disregarded. Regardless of how well-balanced nutritionally, and how stable under adverse storage conditions foods may be, unless troops eat them and remain reasonably satisfied with their lot, the situation is unsatisfactory. It is not enough that food items are wholesome and nutritious. They must, if they are to be well received by troops, have much of the flavor, color, odor, and texture qualities to which men are accustomed. It is in this latter area that radiation processing offers some excellent promise. The facts concerning the hamburger in pocket, briefcase and desk drawer have been repeated much too often to warrant repetition at this time. Rather, there are some other items that can be substituted for hamburger. There are presently in storage at 72° F. at the Quartermaster Food and Container Institute a fairly impressive number of fruits, vegetables, meats and meat products that can be favorably substituted for the hamburger because they are quite acceptable as judged from results of taste test panels. Following are some of the items with the length of time in storage and the respective hedonic rating utilizing a nine-point scale.

Logistical burden will be lightened. The second important military consideration to which radiation

TABLE 4

Acceptability of selected foods irradiated at two levels

Item	Length of storage to date	Hedonic rating		
		Control	2×10^6	3×10^6
Pork Tenderloin	31 weeks	*7.50	6.62	6.75
Ham	31 weeks	7.50	7.19	7.44
Bacon	12 weeks	6.4 (72° F.)	6.6 (100° F.)	
Pork Luncheon Meat	31 weeks	7.50	6.31	5.81
Beef Tenderloin	31 weeks	*6.20	5.38	5.88
Hamburger	31 weeks	6.87	6.80	5.93
Whole Chicken	15 weeks	7.90		7.10
Chicken Thighs	31 weeks	7.00	7.00	6.27
Oysters	18 weeks	6.45	6.25	
		(P) 5.00	(B) 6.37	
			(A) 6.66	
Green Beans	26 weeks	5.5 (72° F.)	5.3 (100° F.)	
Pumpkin	31 weeks	6.67	6.80	6.73
Peaches	26 weeks	6.1 (72° F.)	4.4 (100° F.)	
Pears	31 weeks	7.20	6.12	6.94

* Previous studies.

processing of foods might effect a favorable shift would be in reducing the burden imposed upon the logistics system when it is required to handle large quantities of perishables. Considerable savings can be made in four general areas: (1) cost reduction in food handling; (2) decrease in refrigeration facilities; (3) decrease in maintenance support; and (4) reduction in food losses.

It is estimated that the cost of refrigerated overseas shipments alone is $40.00 per man per year. During World War II with 5,000,000 men overseas, the potential saving may be estimated at $200,000,000.00 per year.

It is not enough simply to ship the perishables under refrigeration. As indicated in the opening remarks on food supplies in Korea, considerable quantities of refrigeration facilities are required at receiving ports, in the supply line, and at the unit mess level. It takes one walk-in and two reach-in refrigerators for each mess feeding 450 men, a total weight of 8500 lbs. equivalent to $2500.00, or 19 pounds per person. For a field army of 400,000 men this is 3800 tons, for 1,000,000 men $5,000,000.00. This is exclusive of the back-up refrigeration required for storage and transit in ships, railroads and trucks. In some situations, such as in submarines and aircraft, the weight and space requirements make it imperative to give every consideration to shedding non-essential weight and impedimenta.

The introduction of radiation processed foods would not only affect the costs in shipping and quantity of refrigeration facilities, but would reduce the number of men needed to operate and maintain these facilities. At a time when manpower is limited, any change that will release men from logistics operations and make them available for combat service should be pursued.

Finally there is a savings of foodstuffs. Many food items contain viable insect eggs at the time of fabrication and subsequently spoil. Such was the case with the cereal bar in the now extinct World War II K-ration. If food items do not require refrigeration then that portion which might be lost because of refrigeration breakdown will be saved. Just what this amounts to is not easy to estimate. However, it is not too difficult to find records that indicate such happenings. One record reveals a post-World War II shipment of vegetables to the Far East. Of this shipment 50% or 250,000 lbs. of fresh vegetables were lost through spoilage. This was a peacetime shipment. The possible increase in cases such as this occasioned by the rush and stress of war is not too difficult to conceive. Even more difficult to assess is the loss of food resulting from the refusal of men to eat the canned thermo-processed items. That this occurs is clear to any one who has been present when the B- or C-ration has been fed for any length of time.

The serious loss here is not the food *per se* but the nutritional elements that are not being consumed by the soldier. Over extended periods this leads to degradation of health and morale.

The degree to which radiation processed foods will eventually be integrated into the feeding situation is at this juncture problematic. However, in summary it is clear that promise exists in several very attractive military potentialities, specifically:

I. Logistic Advantages
   1. Reduction in cost of food handling operations
   2. Decreased requirements for refrigeration facilities
   3. Decrease in money and manpower needed for maintenance support
   4. Reduction in food losses
      a. Insect infestation (Figure 1)
      b. Refrigeration breakdown
      c. Troop refusal because of monotony resulting from prolonged feeding of therm-processed canned rations.

II. Health and Morale
   1. Improved menu acceptability
   2. Meal-type assemblies
   3. Increased use of fresh items because of extended "shelf life."

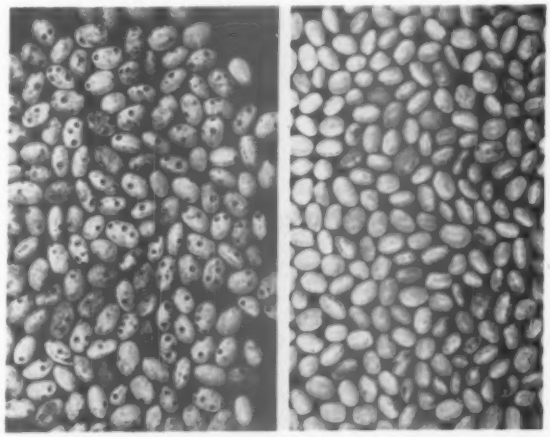

Figure 1. Navy beans, showing infested product (left) and irradiated product (right) free from infestation.

Thus the Military needs foods that will satisfy these requirements just as the world needed a canal across the Isthmus of Panama. Like that project, this basically sound project can fail only if there is inadequacy of effort made toward its accomplishment.

Nutritional Aspects of Air Force Feeding[a]

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THE ROLE THAT NUTRITION plays in the Air Force Food Service Program was recently clearly defined by the Honorable Mr. Donald A. Quarles, Secretary of the Air Force in a memorandum to the Research and Development Associates, Food and Container Institute, Inc. In part, I quote:

> "With every new development in aircraft, new logistical and operational problems are introduced. New jet and rocket propelled aircraft and long range heavy bombers have a decided impact on military feeding. If our aircraft are to provide an advantage over the enemy, the men who operate them must also have a superiority in physical fitness that can be achieved by adequate nutrition."

The responsibility for satisfying nutritional requirements rests upon many different factors and agencies within the Air Force. It is the intent of this presentation to indicate these factors, to describe the interplay between the various agencies concerned and finally to show how application is made at base level.

Objectives of food service for Air Force feeding systems. The Food Service Branch, Air Force Services Division of Air Materiel Command, is charged with the responsibility of technically directing the United States Air Force Food Service Program, worldwide. This organization includes on its staff a nutritionist, a dietitian, a food economist, an equipment specialist, and several technicians qualified in the various production and management aspects of food service. The planning objectives of the Food Service Branch perforce cover many different phases of feeding. However, two of these objectives are pertinent from a nutritional standpoint. They are:

1. To interpret nutritional requirements for ground personnel as established by the Air Surgeon.
2. To translate physiological characteristics of aircrew members into such nutritional requirements as will sustain optimum performance during flight.

It should be stated that these two objectives are based on the consideration that nutrition is a body process and differs from diet. Diet is the regimen of eating, and supports nutrition. Diet, though of prime significance, is only one of the many factors which affect nutrition. Other factors include the physical, emotional, environmental and social forces to which an individual is subjected. Because of this, recognition is given in the planning and implementation of our feeding program to climate, which may vary from extreme cold to extreme heat; to conditions of environmental stress; and to the unfavorable psychological effects produced by certain Air Force assignments.

In order to insure the nutritional adequacy of the Air Force ground feeding program, knowledge of the food supply to a given area is essential. This holds true for the Continental United States as well as for each overseas theater. In the ConUS, annual food plans are prepared by representatives of the Joint Army-Air Force Master Menu Board; plans for overseas theaters are the responsibility of on-the-site food service personnel. These annual food plans are submitted to the Air Materiel Command for review approximately one year in advance of implementation. From these plans the quantity of food available to feed one man per day is ascertained. This quantity of food is analyzed for its nutritional value, using tables of food composition prepared for the Armed Forces by the United States Department of Agriculture. Values obtained are compared with minimum standards established by the Surgeon General's Office. Revision when necessary is recommended.

Recently, it has become the practice for overseas food service and subsistence representatives to handcarry proposed annual food plans to Air Materiel Command. By so doing, we at Air Materiel Command become familiar with individual command problems and requirements; also the overseas representatives benefit from the technical guidance of many of our food service and subsistence technicians. This procedure, we believe, has resulted in more realistic and acceptable feeding programs.

The factor of cost is considered at the time an annual food plan is reviewed. However, cost is and must be secondary to nutritional needs. If nutritional requirements for a specific group within a given command are such as to warrant special foods or addiitonal foods, authority to exceed the monetary allowance for food, as prescribed by Congress in the Ration Act of 2 February 1901, is requested from Headquarters, United States Air Force. Such a requirement, for example, now exists in our Northeast Air Command. Arctic climate, conditions of stress produced by physical remoteness of installations, and problems of morale increase nutritional requirements. Because of this, authority has been granted to the Northeast Air Command to increase the monetary value of food served. This is accomplished by adding increased quantities of food to that prescribed by law. Similar increases are available in Iceland and for installations within the Alaskan Air Command.

Dry and processed foods present a challenge. Food supplies in overseas theaters include reserve levels of the Ration, Operational "B" to be used in the event of emergency. This ration is composed of stable, dry products such as sugar, flour, etc. and processed food items which have no requirement for refrigeration. In other words, no so-called perishable subsistence is included in this ration. However, the stability of these dry and processed foods is limited to approximately two to three years depending upon the food in question. In order to assure acceptability and preclude loss to the Government because of chemical deterioration, these

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 13, 1956.

food reserves are rotated in an orderly fashion. This is accomplished by including them in the normal feeding program.

It is an accepted fact that some Ration, Operational "B" items, especially canned meats and dehydrated foods such as eggs, potatoes, and others, are less palatable and less acceptable than comparable fresh items. If we serve this less acceptable food too often, we find our people rejecting meals wholly or partly in favor of snacks. Nutritional intake can thus be adversely affected. To date, no information exists relative to the maximum extent to which these less acceptable items can be served without unfavorably affecting food intake.

Frequency of serving Ration, Operational "B" items is determined by required reserve levels and troop strengths at a particular activity. Unfortunately, in many areas where reserve levels are high, troop strengths are low. At some major air commands where this situation exists, officials have established policies for the redistribution within the command of Ration, Operational "B" items which are uncommon to those of the normal feeding program. Thus, personnel at any one base are not burdened with disproportionate amounts of the less acceptable foods.

This problem can be alleviated in still another manner. Authority has been granted by Headquarters, United States Air Force, to stock, for reserve purposes, fresh frozen meat in lieu of canned meats. This can be done only where adequate existing freezer space is available. However, freezer space is at a premium at most installations. The Northeast Air Command and the United Kingdom to date are the only two areas where facilities permit us to take advantage of this policy.

During the past year, the Research and Development Division, Office of the Quartermaster General, published data on optimum conditions for storage and handling of semiperishable subsistence items. *(1)*. This publication includes much information which supports the view that refrigerated storage would maintain the quality of dry and processed foods and would prolong stability to at least five years.

Another, more recent report cites studies made by the Quartermaster General's Office which indicate that the use of refrigeration is economical. It eliminates a rapid turnover of expensive food and curtails the use of food for purposes not originally intended. If and when a program of storing operational rations under refrigeration is implemented in overseas theaters, less acceptable foods will be served less frequently, and our problem of curtailed nutritional intake will be simplified.

Nutritional needs are defined by experimental as well as scientific methods. It would be unrealistic to state that food service personnel alone could give a "yes or no" answer to the nutritional needs of aircrew personnel. This holds true for pre-, in-, and post flight feeding. In determining the nutritional needs of this group, many factors must be considered. They are: the mission of a command; the type of aircraft flown; the duration and altitude of flight; and the type of activity performed in flight. Weight, space, and power limitations of aircraft with respect to feeding, and the flight environment must also be taken into account.

In order to gain such knowledge, we make visits to the major air commands where conferences and discussions are held with representatives of the Command Surgeon, flight operations personnel, food service personnel and persons involved with aircrew effectiveness programs. We observe aircraft interiors in order to know at first hand the ilimitations of the aircrew's environment.

The general mission of the Nutrition Section, Aero Medical Laboratory, Wright Air Development Center is to:

> "Develop foods and food packets, methods, techniques, and procedures and integrate them into a smoothly operating feeding system. Accumulate a reservoir of biological facts regarding the interrelationship of nutrition and the human organism, subjected to stresses of existing operations and critical emergencies. Make this knowledge available for Air Force use."

It is apparent from this mission description that a close liaison and working relationship must exist with Aero Medical Laboratory. And it does! There is a continuous give and take of information. Daily staff digests, trip reports, staff studies and surveys are exchanged. Meetings between representatives are scheduled at frequent intervals. We make a joint effort to evaluate the field utility of developmental food items, experimental feeding equipment and proposed feeding systems. We collaborate in the writing of technical notes and reports.

In addition to this intimate association with Aero Medical Laboratory, we work closely with the Quartermaster Food and Container Institute for the Armed Forces. The Department of Defense has assigned to this organization, prime responsibility for research and development in the area of food and food packaging. In conjunction with Aero Medical Laboratory, the Quartermaster Food and Container Institute is responsible for the technological development and adaptation of foods to meet the special nutritional needs of aircrews. The Air Force Liaison Officer assigned to the Institute maintains close coordination with food service. Food service is apprised by him of research and development activities in both flight and ground feeding.

Collaboration with representatives of the Surgeon, at all levels, is maintained. Continuous effort is made to be conversant with technical publications of the School of Aviation Medicine and the National Research Council as well as other research organizations.

A knowledge of flight feeding requirements, active participation with personnel at Aero Medical Laboratory and information gained from the various research agencies mentioned, are basic to the Air Force nutrition program with respect to in-, pre-, and post flight feeding. From such information, food service management tools and procedures are formulated and feeding programs for aircrews are planned. These are disseminated to the various Air Force commands for implementations at base level.

A special type of problem in Air Force feeding. To return to the subject of ground feeding for a moment, let us consider a special situation—one which

involves the feeding of personnel who man our aircraft control and warning system. This system is commonly referred to as the AC and W System.

AC and W activities are situated around the globe. For obvious reasons, however, they are more numerous in the Zone of Interior, Canada, Alaska, Newfoundland and Greenland. In the northern part of the globe, problems are aggravated by climatic conditions, ruggedness of terrain, and remoteness.

No typical pattern or organization chart can be drawn for activities in the AC and W System. Generally speaking, however, one may think of this system as involving three distinct types of units. The first is the AC and W Squadron. This type of unit will range in troop strength from one to three hundred men. It is located in an outlying area, but not too distant from another actviity, such as an Air Force Base, an Army Post or a municipal airport. Also, the squadron is in close proximity to some source of supply, and few feeding problems exist. Then there is the AC and W Detachment, ranging in troop strength from forty to seventy men. Its location is remote and semi-isolated. Here too, however, supplies are usually readily available. Finally, we have AC and W Sites. This type of unit ranges in troop strength form two to nineteen men. It is located in a highly remote and isolated area—one which is frequently secret, and often desolate. At present, there are some AC and W Sites in operation which cannot be reached by automobile, ship or railroad. They are supplied exclusively by air. Sometimes weather conditions require that supplies be dropped by parachute. Feeding problems at AC and W Sites are varied and many. They are currently of much concern to the Air Force.

At an AC and W Site living conditions are best described as being primitive in nature. Quarters are small, bare and barren. The use of water may be restricted. At times it can only be obtained by melting of snow. Toilet and garbage disposal facilities are limited. Sanitation in general is at a low level. Physical comforts are meager. Men are handpicked for their physical and emotional stamina prior to being assigned to these sites. And they need to be!

It should be stated at this time that shortly after World War II, the need for increasing the Nation's security became paramount in importance to the Military and Congress. Appropriation of funds for this purpose was made on an emergency basis. In similar manner radar sites were selected, housing facilities constructed and radar equipment procured. Time was of the essence. Only meager essentials with respect to housing and equipment for personnel were included in the plans.

Tasks assigned to personnel at AC and W Sites are monotonous, tedious, boresome, and confining in nature. These airmen must accomplish a most important task within the Air Force mission—early warning in the event of enemy attack. Efficiency must be maintained at a high level. In order to achieve this, food should be acceptable, extremely palatable, adequate in quantity and optimum in nutritive value.

Unfortunately, at many of these stations, food service leaves much to be desired. This, in part, can be attribued to the fact that prevailing methods of feeding are deficient from an operational standpoint. Restrictions are placed on the kind of food service equipment which can be issued and used because of available space and power. The small numbers of men involved make it economically unsound to assign food service personnel to them. Preparation of food by those who are untrained is often below an acceptable standard. Remote stations may be inaccessible for extended periods of time due to inclement weather. Delivery of food on a routine basis is difficult.

Meals presently authorized for these conditions possess numerous limitations. In order to resolve the problem, a proposal is currently being evaluated for the development of a new system of feeding. This system would include complete, precooked or partially cooked meals with the following characteristics:

a. Utilization of highly acceptable and nutritionally adequate foods.

b. Individually packaged meal components which can be commercially procured.

c. Complete meals, i.e., meals which require no supplementation.

d. Controlled food portions.

e. Elimination of inedible wastes.

f. Foods packaged, stored and cooked in the container from which the food is eaten.

g. Minimum requirement for preparation.

h. Minimum amount of training and effort for proper utilization.

It is anticipated that this system will provide a means of furnishing complete hot meals with a minimum of equipment, and without dependence upon trained food service personnel.

There is still one other phase of the Air Force Nutrition Program which should be mentioned. The Air Defense Command provides a series of talks in nutrition for the wives of fighter pilots and radar observers. The effects of flight on the human body, basic dietary principles and sample meal plans are discussed. This program was instigated because the average aircrew member will be on alert approximately one-third of the time. When not on alert, he will be eating his meals at home. Proper nutrition is an all time affair and must be maintained in order to cope with the demands of modern military life.

CONCLUSION

In conclusion, I wish to say that we have three kinds of people who make up the Air Force. We have trained people to fly; we have people for support; and we have people to maintain these forces. Each group has distinct nutritional requirements. Our food service program, as this presentation has attempted to indicate, is mindful of these requirements. We have but one objective and that is the maintenance of the most effective fighting force in the world.

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Preparation and Evaluation of Precooked, Dehydrated Bean Products[a]

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(Manuscript received June 13, 1956)

IN THE PAST, DEHYDRATION has provided the Military Services with a means for the preservation of foods which has permitted significant savings in storage and transportation requirements. However, at the present time, the impact of radical new weapons on organizational, tactical, and logistical planning demands that new concepts of military feeding be utilized. Now, combat troops must have maximum mobility and dispersion for varied lengths of time. In order to obtain the mobility desired, it becomes necessary to reduce materiel transport to the minimum. Presently available dehydrated foods only partially satisfy this heightened requirement, and it has been necessary to attempt modifications aimed at minimizing equipment and personnel needs.

Precooked, dehydrated foods, which can be prepared by the simple addition of hot water (190°-200° F.) with no added cooking, appear to offer the means for reducing the demands for specially trained food service personnel and for special preparation and serving equipment.

A satisfactory method for dehydrating baked beans was described by Esselen and Davis *(3)*, in 1942. However, the product described was produced from baked beans with sauce (a 5 to 6 hour process) and a dehydration schedule of 8 to 10 hours at 140° F. This item was rehydrated by soaking for 1½ hours, followed by a short heating time. This type of product, although acceptable at that time, would not satisfy the present need for food items which would rehydrate in 5 to 10 minutes without additional cooking.

MATERIALS AND METHODS

The Michigan Pea (Navy) variety of dried beans was selected for intensive study since it is a variety normally used in combination food dishes, and also because it was considered the most suitable for dehydration *(3, 4)*.

The dry beans were washed and soaked for at least 8 hours *(2)* in water at a temperature of approximately 60° F. The soaked beans were then screened to remove those which had not swelled.

A range of initial pre-cooking conditions was established:

1. Atmospheric boiling schedules at 212° F. for periods of 30 to 160 minutes,

2. Pressure steam cooking schedules at 245° F. 13 p.s.i. for periods of 10 to 30 minutes.

The cooked beans were subjected to the following pretreatments before dehydration:

1. Control, i.e., no pretreatment,

2. Sugar dipping in 30° Brix sucrose solutions for periods of 1 to 15 minutes,

3. Freezing before dehydration, wherein the product was placed in the dehydrator in the frozen state.

Dehydration was conducted in a Proctor and Schwartz through-air-flow tray dehydrator utilizing a low humidity schedule.

With this unit, dry bulb temperature could be controlled to ±1° F. Humidity was controlled by means of direct steam injection into the chamber in front of the blower fan.

Moisture contents of the materials used in this study were determined by the standard A.O.A.C. method in a vacuum oven for 6 hours *(1)*.

The dehydrated product was evaluated visually with special emphasis on bursting, splitting, and acceptability as judged by over-all appearance.

The product was rehydrated in near boiling water (190°-200° F.) for 5 minutes and examined for completeness of rehydration, i.e., texture, appearance, flavor, and odor. The greatest emphasis was placed on the ability of the product to rehydrate in approximately 5 minutes; hence, this governed the rating of the other factors.

Rehydration ratios were determined as $\frac{Wr}{Wd}$, where Wd is the weight of dehydrated product and Wr is the weight of the rehydrated product *(6)*. In addition, these products were evaluated to determine their ability to rehydrate in combination with other dehydrated items.

RESULTS AND DISCUSSION

A. Cooking

1. *Atmospheric boiling.* At least 105 minutes were necessary to obtain a completely cooked, mealy textured bean. This length of time appreciably lengthened the processing cycle and was deemed unacceptable for maximum production capacity or efficiency.

2. *Steam pressure cooking.* In the range of 10 to 30 minutes cook at 245° F., 13 p.s.i., the 20-minute process gave the most satisfactory texture characteristics. A longer cook rendered the product mushy; a shorter cook resulted in graininess.

B. Pretreatments

1. *Sugar dipping.* A 30° Brix sugar solution dip for 1, 5, 10, and 15 minutes lessened the degree of bursting to 30-75% after 1½ hours dehydration at 130° F. The control samples, on the other hand, exhibited 80-100% bursting. Although the sugar dip lessened the bursting effect, the samples were hard and grainy upon rehydration.

2. *Freezing.* Prefreezing minimizes bursting during dehydration at all temperatures of the low humidity schedule (Table 1). The over-all appearance of the prefrozen dehydrated products was excellent. (Figures 1 and 2).

TABLE 1
Low humidity schedule

Dry Bulb ° F.	Wet Bulb ° F.
130	78
150	84
170	88
190	94

C. Dehydration

1. The low humidity dehydration schedules produced an acceptable bean only when the prefreezing treatment was used (Table 1). In this case, as noted previously,

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 12, 1956.

a highly acceptable product was the result. The 170° F. dry bulb and 190° F. dry bulb prefrozen runs were judged to have produced the best rehydrating beans. However, the other prefrozen runs produced beans which were only slightly less acceptable.

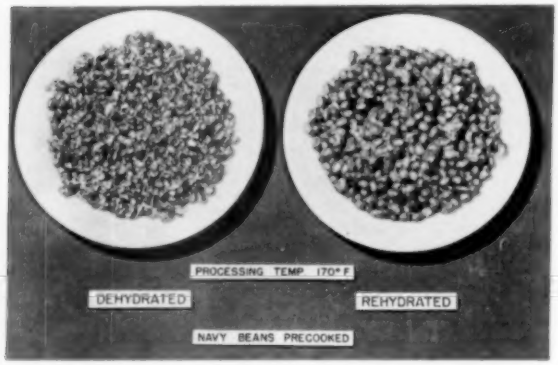

Figure 1

2. The dehydration cycles of the prefrozen beans were shorter than those of the non-frozen beans (see Figure 3) to reach a safe moisture level of less than 4% *(5)*.

3. Recognizing that the introduction of freezing would increase the cost and complicate the process, a high humidity schedule was investigated to determine whether bursting could be controlled. At 170° F. dry bulb and 150-156° F. wet bulb for 1½ hours followed by progressively decreasing humidity until 88° F. wet bulb was reached, the bursting effect was lessened but a more dense bean was produced. Rehydration of this material resulted in a grainy product even after 10 minutes. More work is being carried out using high humidity conditions to determine whether longer cooks and lower initial dehydration temperatures will produce a good bean product.

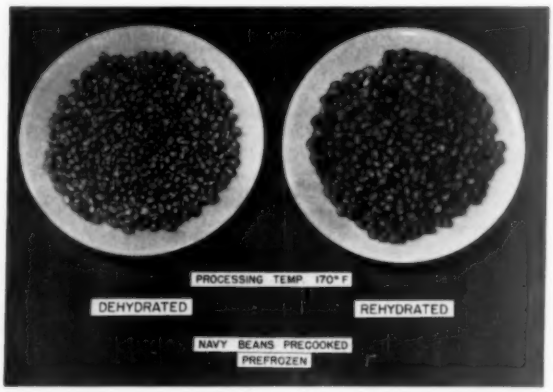

Figure 2

D. Rehydration

1. The samples were covered with near boiling water (190° F.-200° F.) and allowed to stand for at least 5 minutes. The product was judged to be completely

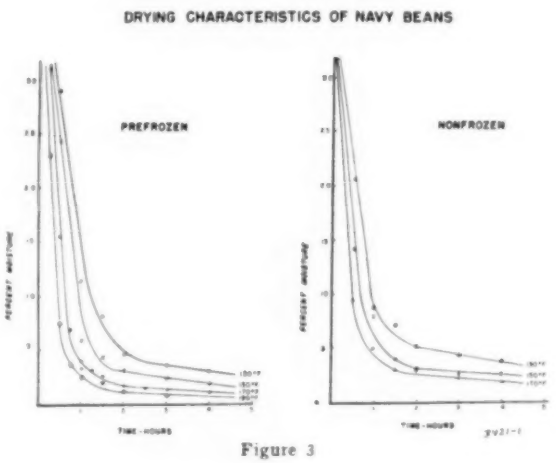

Figure 3

TABLE 2
Selection of treatment schedules

Run No.	Cooking	Pretreatment	Drying	Texture
1	Atmospheric Boiling 105 minutes			Mealy
2	a. 245° F. 13 p.s.i. 10 minutes b. 15 minutes c. 20 minutes d. 30 minutes			a. grainy b. grainy c. mealy d. mushy
3	a. 245° F. 13 p.s.i. 20 minutes b. c. d.	30° Brix sugar dip 1 min. 5 min. 10 min. 15 min.	130° F. 1½ hours	hard and grainy. Bursting decreased by 30-75%
4	a. 245° F. 13 p.s.i. 20 minutes b. c.	No Freezing	130° F. 4 hours 150° F. 4 hours 170° F. 4 hours less than 10% R.H.	Excessive splitting and mushy
5	a. 245° F. 13 p.s.i. 20 minutes b. c. d.	Freezing	130° F. 4 hours 150° F. 4 hours 170° F. 4 hours 190° F. 4 hours less than 10% R.H.	a. grainy b. grainy c. mealy d. mealy

rehydrated when it had assumed a whole bean shape and mealy texture. In the acceptable samples, an average rehydration ratio of 2.5:1 was obtained.

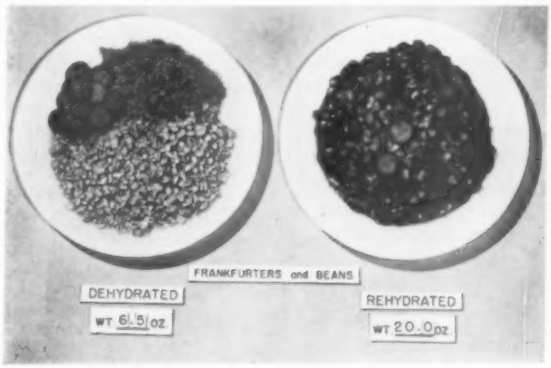

Figure 4

E. Other varieties

1. Once the optimum conditions had been determined for Michigan Pea Beans, exploratory work was conducted on other varieties. California Pea and Great Northern beans also yield acceptable products when processed as stated above. An acceptable Red Kidney bean precooked product can be produced by subjecting the soaked beans to pressure steam cooking for 15 minutes at 245° F., 13 p.s.i., prefreezing, and then dehydrating at 130° F. dry bulb and 78° F. wet bulb (see Table 1) for a sufficient length of time to reach a safe moisture level of less than 4%.

F. Combination items

1. Precooked, dehydrated Michigan Pea beans may be formulated into Beans and Tomato Sauce or Beans, Franks and Tomato Sauce using all dry or dehydrated ingredients, i.e., tomato powder, spices, sugar, salt, and precooked, freeze dried frankfurters (Figure 4). Precooked, dehydrated California Pea or Great Northern beans may be substituted in the above combinations.

2. Precooked, dehydrated Red Kidney beans may be mixed with precooked, freeze-dried hamburger, tomato powder, chili powder, and seasonings to give a completely precooked chili con carne. Without the hamburger it becomes a meatless chili dish.

3. The meat combination dishes require 10 minutes for rehydration in near boiling water since the meat items are limited in rehydration rate.

Future work. Additional studies will be conducted to determine whether high humidity drying can be used to replace the pre-freeze treatment.

Storage studies have been initiated to obtain storage stability data for the various bean products and combination dishes enumerated herein.

SUMMARY

The effects of certain variables on the production of precooked, dehydrated bean products are given. An acceptable precooked, dehydrated bean product was produced on a laboratory scale using dry Michigan Pea beans (Navy). The beans were soaked for at least 8 hours followed by steam pressure cooking at 245° F., 13 p.s.i. for 20 minutes; the cooked beans were then frozen and dehydrated at either 170° F. dry bulb, 88° F. wet bulb (Figure 2) or 190° F. dry bulb, 94° F. wet bulb for 1½ or 1¼ hours, respectively. Great Northern and California Pea beans may also be dehydrated using these conditions, but Red Kidney beans require a shorter cook and lower dehydration temperature.

Acknowledgments

The technical assistance of Gerald Bard in the preparation and appraisal of the bean samples is gratefully acknowledged.

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New Foods at Altitude[a]

(Manuscript received June 13, 1956)

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In recent years industrial research and development have been directed toward "ready to eat" and "brown and serve" types of food. Such canned foods as beef stew, whole chicken, and spanish rice need only be heated before serving. Precooked frozen foods are rapidly growing in popularity and "brown and serve" bakery goods are widely available. Many of these values added to foods by modern technology are directly applicable to Air Force in-flight feeding. To appreciate this, a review of the feeding situation in military aircraft may be helpful.

The limitations imposed on flight feeding differ in each type of aircraft. Large propeller driven cargo and transport aircraft impose the least limitation. Hot cups for heating water, insulated containers for storing beverages, refrigerators, ovens, and ample storage space for food, utensils, and accessories are usually available. Crewmen are able to move about the aircraft to assemble and heat foods, consequently feeding can most closely approach an ideal aboard these larger aircraft.

The most extreme feeding limitations are found in jet fighters. The cockpit is crowded with instruments and controls. The pilot cannot move out of his seat. He is heavily clothed and carries a parachute, oxygen, and other equipment. Stowage space for food is extremely limited. No food heating or cooling equipment can be provided. The pilot must pay constant attention to flying the aircraft, and only one hand can be used for eating and drinking. In-flight refueling has greatly lengthened the time these aircraft can remain in flight. In fact the only limit to flight duration is the time the pilot can fly the aircraft and flight durations are long enough to require feeding.

Flight situations vary between these two extremes. In all cases, however, it is necessary to separate the place of food preparation from the place of consumption. Food service personnel are not available aboard aircraft. Therefore, the more "ready to eat" a food is, the better it fills flight feeding requirements. Thus, the utility of a food is of primary concern in its development.

Stability requirements for foods used for in-flight feeding are more severe than for foods for civilian use. Refrigeration is available on comparatively few aircraft. Foods are also needed that can be stockpiled for long periods in "ready to eat" form to be used in case of emergency or in support of large operations and in changing theaters of operation. Thus, there are two stability factors of interest to the Air Force. Food poisoning resulting from perishable meals prepared in the flight kitchen must be avoided. Secondly, meals prepared commercially in ready to eat form must retain their acceptability during long term storage. Where civilian shelf life is calculated in months, military storage times need to be reckoned in years.

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 13, 1956.

High acceptability is even more important in flight than it is on the ground. Flight duties and the aircraft environment tend to decrease appetite. Foods must be high in acceptability so they will be eaten in sufficient quantities. Furthermore, good food is a positive morale factor; poor food is detrimental to morale.

Nutritional considerations are becoming more important as flight durations increase. Proper balance of nutrients must be maintained, but more important, certain undesirable responses must be avoided in high altitude flight. For example, gas forming foods can not be used, and excessive fats may contribute to airsickness.

From this, we see there are four general criteria to be considered in foods and meals for use in-flight: The first is utility. The crewman must be able to easily prepare and consume the food. Acceptability must be high enough to insure the consumption in adequate quantities. Stability must be great enough to avoid the possibility of spoilage. Nutritionally, the meals should be balanced and must possess no undesirable after effects.

Flight feeding systems. The first widely used flight feeding system was the sandwich meal. This is a box lunch containing sandwiches, fruit, candy, and beverages. Fried chicken, salad, or cookies are also frequently included. At present, this is the most commonly used in-flight meal in the Air Force. Of the development criteria mentioned previously, most of the research on this meal has been directed at increasing utility. One problem being investigated is the drying of sandwiches at altitude. Various wrapping materials and methods have been compared to determine relative resistance to moisture transfer. Glassine and light weight waxed paper have been found unsuitable as wrapping materials. Heavier waxed papers, and various plastic films have been found suitable. There is a trend toward using commercially packaged individual servings of components such as cookies, crackers, catsup, mustard, salt, pepper and such items. This aids in maintaining purity of the products and simplifies preparation of meals by reducing handling.

The feasibility of developing an indicator to show when food poisoning toxin could be present is being investigated. The use of such an indicator will allow more than the present 5 hour time limit between preparation and consumption, since in many cases the meals are kept at temperatures such that toxins could not have formed in this short time.

The next feeding system to be widely used contains canned foods. This is the Food Packet, Individual, In-Flight. This packet contains 4, 300 x 200 cans which contain meat, bread, fruit, and dessert. In addition, an accessory packet provides instant coffee and tea, soluble cream, sugar, gum, can opener, spoon, and napkin (Figure 1).

Research has been directed primarily at increasing acceptability. Several packaging modifications have recently been made. A white carton and accessory packet envelope are used. The envelopes containing

coffee, tea, cream, and sugar are either white or the natural silver color of the foil. This gives the packet a more sanitary appearance. The contents are printed on the carton to allow the crewman his own choice of menu. New menu items are continuously under development. Canned bread has replaced canned crackers. A canned pecan roll has been included as a new dessert item.

Figure 1. The Food Packet, In-Flight, Individual has undergone many improvements over its original design.

Another dessert item, a canned chocolate nut roll is being developed. A stable butter type spread for use with the bread is also being developed. The canned meat items are more acceptable when heated than when eaten cold. However, heating is not always possible aboard aircraft. Canned tuna is being considered as a new meat component since it is palatable cold.

The precooked frozen meal is the most recent feeding system to gain widespread Air Force use. This meal is similar to commercial precooked frozen meals. Six of the 10 menus used by the Air Force consist of a meat, potato, and vegetable component. Of the remaining 4 menus, two are casseroles and two are breakfast menus. The tray size is somewhat smaller than most commercial meals so that aircraft ovens and refrigerators can be as compact as possible. Present research is directed toward increasing acceptability, stability, and utility of these meals. The acceptability of all components is being improved by studying process variables in their production, and the effects of mono-sodium glutamate. In addition, new menu items which will meet stability requirements are being investigated. Pork items which will be stable during storage are also being developed. Microbiological standards are being further studied to insure high quality without unreasonable demands on the producers of these meals. It has been well established that precooked frozen meals are sensitive to storage temperatures above 0° F. An ice cube indicator is presently being used to show whether meals have inadvertently been thawed and refrozen. Melting of the ice cube indicator prevents consumption of foods which might cause food poisoning. However, acceptability can be severely affected by storage at temperatures between 0° and 32° F. Therefore, an indicator sensitive to this temperature range is being developed.

Feeding under highly restricted flight conditions. The meals that have been described cannot be consumed under the most restricted flight conditions mentioned earlier. In the most restricted situations feeding must be accomplished with a tube arrangement through a helmet aperture. Three types of foods are being developed for use in restricted situations. They include liquid foods, food tablets, and semi-solid foods.

A large variety of liquid foods is being developed. Highly acceptable fruit and vegetable juices are already widely available. An improved chocolate milk and a lemonade have been approved and specifications are being written. Prototypes of caramel and coffee flavored milk drinks are now available and are being field tested. Development of meat-type drinks has not yet been completed, but a canned liquid chicken and a canned liquid ham show considerable promise.

Prototypes of a variety of food tablets have been produced. Chocolate butter cream, cheese, cookie, and milk food tablets are being field tested in conjunction with a special dispensing device being developed for them.

The feasibility of using small cans containing bite size solid foods is being studied. These items will have good stability. It is intended the cans be opened just before take-off since opening them in flight would be difficult.

Work has recently been initiated to develop semi-solid foods in tubes for use at high altitude. These foods will be packed in metal or plastic dispensing containers with elongated spouts which can fit into a helmet aperture. This work has not yet reached the prototype stage of development.

A large number of new foods have been discussed and evaluated against requirements unique to flight feeding. There is one other problem which merits attention although not connected with food development per se. That is, the development of an easy to open can. In many flight situations, a sealed can is a real obstacle to consumption of food. No satisfactory method of opening a can with one hand and without using a table or shelf surface has been found.

Flight feeding must be supported by basic research. Nutrition, acceptability, and utility requirements of flight feeding differ from normal ground feeding. The utility of feeding systems can be predetermined by inspection of the aircraft concerned and proven by field testing. Since aviation is a comparatively new field, a basic research program is necessary to guide development of food with optimum acceptability and proper nutrient content. In the nutrition area, basic research is directed toward determining effects of food on performance, determination of optimum water intake levels, and the causes and alleviation of gas pains.

In studying the effects of nutrients on aircrew effectiveness, an attempt is being made to find the amount of food needed for optimum performance by the crewman. Overfeeding causes drowsiness or sluggishness, while under feeding increases susceptibility to fatigue. Various caloric intakes will be provided to crewmen under simulated flight conditions. Physiological and

psychological tests will be made and compared with the food intake levels.

High altitude chamber studies are in progress on the closely related and important problem of dehydration of the human body. Ground level studies indicate that a loss of 2% of body weight in water markedly reduces efficiency. The importance of maintaining a proper fluid balance in aircrews is immediately apparent. Dehydration may be extensive at altitude primarily through insensible water loss due to practically zero humidity. In addition, thirst is not always a strong enough sensation to motivate drinking enough liquids to maintain a favorable liquid balance. Research on this problem is aimed toward determining more exactly the amount of water lost under various flight conditions so that enough liquids may be made available to maintain the proper state of hydration of the body. Water balance is closely related to food intake. For that reason, both food and water studies are being conducted with the same method of approach.

Another problem under study is that of abdominal gas pains at altitude. Because of the lower atmospheric pressure at altitude, gases in the intestine expand. This expansion may cause very severe pain. It is not uncommon for gas pains to incapacitate a pilot. This problem is one of gastro-intestinal physiology and must be treated as such. It is possible, however, that certain foods may alter the sensitivity of the gastro-intestinal tract, or that they may actually be gas forming. Neither the source of the gas nor the mechanism causing the pains has been established. A research study designed to reveal these facts is currently being conducted. Present indications are that the rate of ascent is more important than final altitude reached. When the nature and causes of these pains are understood, the effect of food upon incidence and severity can be established.

The importance of acceptability of foods furnished aircrew members has been pointed out above. A study is now being conducted to determine the effects of dry oxygen on the taste threshold. Subjects are asked to identify solutions of the four primary taste substances in varying concentrations before and after breathing oxygen for periods of two or more hours. The strength of the solution at which they are first able to discern and identify the taste is recorded. Foods which are highly acceptable at ground level, may, because of the breathing of dry oxygen, change in their acceptability at altitude.

A varied research and development program required. The basic and varied research program being conducted is aimed at providing practical biological information to be used in selecting, developing, and using new foods at altitude. This will better enable the Air Force to provide foods that will meet the stringent limitations imposed on man in modern, high speed, high altitude flight.

Development of foods for flight feeding requires research in most major fields of food technology including canning, freezing, dehydration, acceptance methods, food microbiology, and packaging. In addition, research in nutrition and physiology contribute a share. Evaluation of foods is based on utility, acceptability, stability, and nutritive quality. Modern industrial research is producing food items requiring little or no modification to meet flight feeding requirements. This is true since convenience added to a product for the housewife is similar to the utility requirements for flight feeding. High consumer acceptance is essential to both areas. Increasing attention to nutrition by industry is benefiting the Air Force. However, shelf life requirements for the civilian market are frequently not as demanding as military stability requirements.

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Treatment of Wheat with Ionizing Radiations. III. The Effect on Breadmaking and Related Properties[a]

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THE FIRST EXPERIMENTS in this series *(5)*, designed to determine the effect of irradiation upon the biological, biochemical, and technological properties of wheat, indicated that x-irradiation of gluten when dry or in aqueous suspension results in decreases in viscosity. The second study *(6)* showed that treatment of the intact grain when damp or dry with gamma ray dosages between 125,000 and 625,000 rep can eliminate fungal respiration, apparently without change in protein solubility and fluorescence of grain extracts. Dosages in excess of 625,000 rep produced adverse changes in these factors, particularly following a period of storage of the grain. This study clarified the effect of such radiations on wheat quality at dosage levels sufficient to eliminate fungal growth and respiration, which are the major causes of deterioration and heating of grain in storage.

Brownell *et al. (3)* have reported that cake flour and

[a] Contribution No. 275, Department of Flour and Feed Milling Industries, Kansas Agricultural Experiment Station, Manhattan.

all-purpose flour treated with gamma radiations at levels lethal to flour-infesting insects (20,000 rep) showed no change in the quality of cakes baked from such flours. Heavier dosages resulted in some decrease in cake and bread quality. The baking techniques employed by these workers were essentially those of a housewife rather than of a commercial baker.

The present study was concerned with treatment of normal dry wheat with gamma radiation at levels up to 1,000,000 rep. The breadmaking and related properties of flour milled from this grain were then evaluated. The dosage range employed covered that required for the elimination of storage fungi as well as insects. Baking technics and quality evaluation methods were essentially those used for commercial pan bread.

MATERIAL AND METHODS

Wheat used for this study was an unusually high quality sample of hard red winter wheat, Concho variety, grown on the Agronomy Farm at Kansas Agricultural Experiment Station in 1954. The test weight was 62.6 lb. per bushel, moisture was 8.3%, protein content 14.0%, and germination 96%. From the time of harvest the sample was stored in a cold room at 50° F.

Forty-eight No. 2 cans consisting of four groups of 12 were filled with the wheat, and after sealing, were shipped to the Quartermaster Food and Container Institute for the Armed Forces in Chicago whence they were forwarded to the Materials Testing Reactor at Arco, Idaho, for gamma irradiation. This reactor delivered at this time approximately 1.98×10^6 roentgens per hour. The following are calculated dosage treatments based upon time of exposure:

Sample	Radiation time		Radiation dosage rep
	minutes	seconds	
I	3	47	125,000
II	7	35	250,000
III	15	15	500,000
IV	30	18	1,000,000

When the cans were returned, each treatment group was opened separately, thoroughly mixed, and a major portion of the sample conditioned for milling by the addition of a calculated amount of distilled water to bring the moisture content to 15.5%. A control sample, which received no irradiation, was similarly conditioned. After additional mixing and standing overnight, the 5 samples were milled in the Buhler Experimental Mill to an average flour extraction of 60%.

A number of other tests were conducted on the remainder of the grain. Germination evaluation was carried out by the Kansas State Seed Testing Laboratory. Moisture content and fat acidity determinations were carried out according to procedures outlined in *Cereal Laboratory Methods (2)*. Fluorescence determination on acid extracts, indicative of protein-sugar interaction, and transmittancy of potassium sulfate solution extracts as an index of protein solubility were conducted as previously outlined *(6)*. Sedimentation value, which is a determination of the extent of protein hydration when treated with lactic acid and which is considered to be a preliminary indication of breadmaking quality *(7)*, was determined by the most recently recommended procedure.[b]

Flour samples were analyzed for moisture, protein, and ash contents, and also for Maltose Value, by procedures prescribed in *Cereal Laboratory Methods (2)*. The Maltose Value is an index of autolytic sugar production reflecting both amylase activity and starch substrate susceptibility.

Dough development curves were obtained using the Brabender farinograph and employing the constant flour weight method. From these curves various flour and dough properties were derived. Other physical dough measurements were made with the Chopin alveograph, which blows a bubble of dough by means of water displacement. The instrument was operated essentially as described by Aitken *et al. (1)* and the curves were interpreted in the manner discussed by these authors.

Amylograph determinations indicative of maximum starch gelatinization viscosity, were carried out as directed by Johnson *(4)* using a ratio of 65 g. of flour to 450 ml. of buffer solution.

One-pound commercial pan bread loaves were baked by a straight dough procedure with and without potassium bromate, employing a regular rich commercial formula as follows:

Ingredient	Weight %
Flour	100.0
Yeast	2.0
Sugar	6.0
Salt	2.0
Non-fat dry milk solids	4.0
Malted wheat flour	0.5
Hydrogenated shortening	3.0
Ammonium phosphate	0.1
Potassium bromate	0, 1, and 3 mg. percent
Water	As required for proper absorption

Bread was scored for various characteristics as follows:

Loaf Characteristic	Maximum Score
Volume	20
Break and shred	5
Crumb color	5
Grain and texture	35
Absorption	10
Dough handling properties	15
Mixing tolerance	10
Total	100

RESULTS AND DISCUSSION

The effect of various gamma radiation dosages as high as 1,000,000 rep when applied to dry sound wheat, on various biological and biochemical properties of the grain is shown in Table 1. Germination (originally 95%) was reduced by nearly two-thirds with a dosage of 125,000 rep and virtually to zero by the 1,000,000 rep treatment. Fat acidity, however, was completely unaffected by radiation treatment at these levels, confirming results found in the previous study *(6)*. Fluorescence of acid extracts, as well as protein solubility as indicated by transmittancy of potassium sulfate extracts, was also unchanged. This result also confirmed those found in the previous study, where considerable changes in these flour properties occurred only after a period of storage of the most heavily treated samples.

TABLE 1
Biological and biochemical properties of irradiated wheat

Irradiation dosage	Germination	Fat acidity	Fluorescence	Transmittancy
rep	*%*	*mg. KOH/100 g.*	*Scale units*	*%*
Control-0	95.0	14.0	20.3	17.2
125,000	34.0	14.5	20.1	17.0
250,000	5.0	14.5	20.3	16.8
500,000	4.0	13.5	20.6	16.1
1,000,000	1.0	14.0	20.9	16.6

Biochemical analyses of the flours produced from the irradiated wheats appear in Table 2. The farinograph

[b] Private communication from A. J. Pinckney, U. S. Department of Agriculture, Agricultural Marketing Service, Washington, D. C.

and alveograph values shown in Table 3 are derived from typical curves appearing in Figure 1.

The flour moisture content (Table 2) was about normal for freshly milled flour of this type. The ash content indicates these flours to be of short patent quality. The protein content as well as the ash content of these flours suggests a rather uniform extraction rate. Sedimentation value showed a regular decrease

TABLE 2
Biochemical properties of flour milled from irradiated wheat

Irradiation dosage	Moisture	Protein	Ash	Sedimentation value	Maltose value	Maximum amylograph viscosity
rep	%	%	%	*ml.*	*Maltose/10 g.*	*B. U.*
Control-0	12.9	13.8	0.39	41.1	179.0	960
125,000	13.2	13.6	0.37	37.4	185.5	520
250,000	13.5	13.8	0.37	34.9	207.6	330
500,000	13.7	13.9	0.37	29.5	222.3	180
1,000,000	13.8	13.8	0.35	21.8	249.3	90

with irradiation, indicating a loss in imbibitional capacity of the wheat gluten protein. The marked and regular increase in maltose value from 179.0 for the untreated flour to 249.3 in the case of the samples receiving 1,000,000 rep, was accompanied by a corresponding but even more drastic decrease in maximum amylograph viscosity from 960 to 90. Since it is difficult to conceive that irradiation would cause an increase in amylolytic enzyme activity in wheat, it becomes apparent that these changes reflect primarily a sharp increase in the susceptibility of the starch fraction to amylase attack, with increased production of reducing sugars as indicated by the elevated maltose values. Obviously starch structure was drastically disrupted by the radiation dosages within the range applied.

Farinograph absorption values (Table 3) show an apparent initial slight decrease with irradiation followed by an increase in the case of the 500,000 and 1,000,000 rep dosages. Dough development times showed a decreasing trend with dosage except for the anomalous value for the 500,000 rep treatment. Mixing tolerance index, which is a measure of the breakdown of dough structure following attainment of maximum dough development, shows a regular increase with irradiation. The alveograph data indicate that radiation produces a progressive increase in dough stiffness (height of

TABLE 3
Dough physical properties of flour milled from irradiated wheat

Irradiation dosage	Farinograph values			Alveograph values				
	Absorption	Development time	Mixing tolerance index	G[1]	P[2]	L[3]	S[4]	W[5]
rep	%	*min.*	*B.U.*					
Control-0	71.1	5½	40	24.6	77.2	127.8	40.9	263
125,000	70.1	4½	50	21.7	89.0	97.8	42.2	268
250,000	70.9	4½	60	18.8	93.0	73.7	34.2	238
500,000	71.9	5	60	21.1	93.0	93.0	39.8	251
1,000,000	72.3	3½	70	17.9	95.3	64.5	29.3	181

[1] A value proportional to volume of liquid in gasometer at point of rupture of dough bubble.
[2] Maximum curve height (cm.).
[3] Maximum curve length (cm.).
[4] Area under the curve (cm.²).
[5] Work function, in ergs. $W = K \times C \times \frac{S}{L}$,
where K = gasometer correction constant,
C = a value derived from volume of liquid in gasometer.

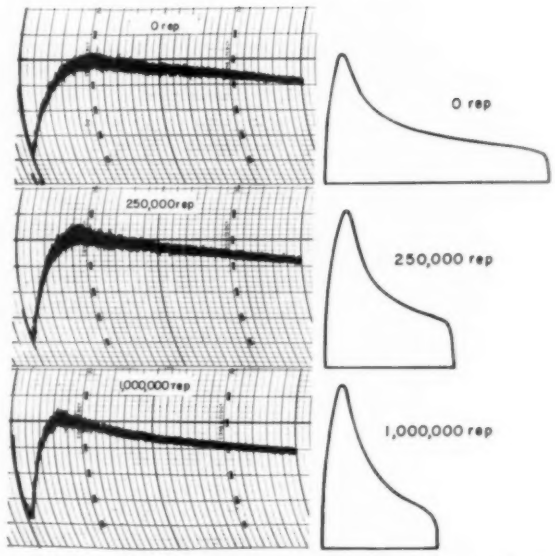

Figure 1. Dough physical properties produced by treatment of wheat with 0 rep 250,000 rep and 1,000,000 rep of gamma radiation. Farinograms are on the left and Alveograms on the right.

curve) and decrease in distensibility (length of curve). The values for the 500,000 rep dosage are anomalous; however, the work function "W," which is an indication of overall flour strength, appeared to increase with the 125,000 rep dosage but decreases with irradiation beyond this treatment level.

The loaf volume and loaf score data for one-pound commercial pan bread baked from these flours using the straight dough rich commercial formula, with and without potassium bromate, are shown in Table 4, and a photograph of the loaves themselves appears in Figure 2. These data indicate that untreated flour produced bread of excellent volume and loaf score which showed good response to potassium bromate. It is of interest to observe that the 125,000 rep treatment appeared to cause an improvement in these quality values, which could be even further enhanced by potassium bromate. Potassium bromate caused an improvement in loaf

TABLE 4
Quality characteristics of bread derived from irradiated wheat

Irradiation dosage	Loaf volume (ml.)[1] at various $KBrO_3$ levels (%)			Loaf score[1,2] at various $KBrO_3$ levels (%)		
rep	0.000	0.001	0.003	0.000	0.001	0.003
Control-0	2633	2962	3000+	82	92	94
125,000	2745	2970	3000+	83	93	95
250,000	2702	2972	3000+	79	89	88
500,000	2745	2907	3000+	78	84	85
1,000,000	2490	2890	2938	66	73	73

[1] Replicate loaves.
[2] Max. score = 100.

volume and crumb quality at all irradiation dosages. This indicates that the improving effect of irradiation and of bromate occur independently of each other. Dosage of 250,000 rep caused some downgrading of crumb properties although the general bread quality was still good. Irradiation treatments beyond this level

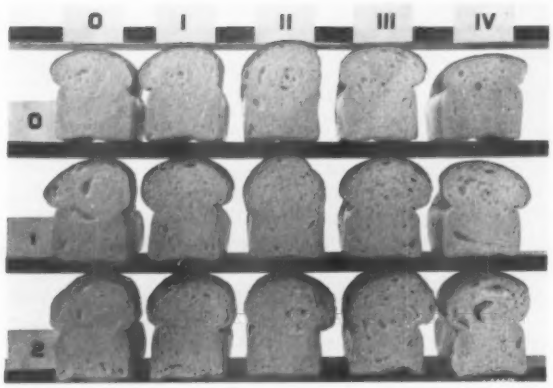

Figure 2. Commercial-type 1-pound loaves derived from gamma irradiated wheat. Horizontal rows, left to right, represent dosages of 0, 125,000, 250,000, 500,000 and 1,000,000 reps respectively. Vertical rows, top to bottom, indicate potassium bromate additions of 0, .001 and .003%.

resulted in a decline of loaf quality. It should be noted, however, that all of the bread—even that from wheat treated with 1,000,000 rep—was acceptable. Superficial organoleptic examination of these loaves indicated no easily detectable changes in flavor and odor.

CONCLUSIONS

Significant effects of gamma radiation in the dosage range from 125,000 to 1,000,000 rep on the quality characteristics of bread flour milled from wheat of high quality were observed. These included regular decreases in gluten imbibitional capacity (sedimentation value), and autolytic sugar production (maltose value) as well as drastic decreases in starch gelatinization viscosity (amylograph value). This marked change in starch properties is perhaps the most significant factor elucidated by these studies. Changes in dough mixing curves included a tendency toward shorter dough development time and toward accelerated breakdown of doughs with over-mixing. Radiation also caused doughs to become increasingly stiff and less extensible and to lose "strength." Bread quality from all treatment levels was surprisingly good. An apparent improvement of all loaf properties over those of the control occurred at the 125,000 rep treatment level, a result which may be of some practical interest. A decrease in crumb and loaf volume characteristics was evident at dosages beyond 250,000 rep.

The acceptable quality of bread produced even from wheat treated at the highest irradiation levels, despite significant changes in biochemical factors and dough physical properties, was probably due to the high protein level in this wheat sample as well as to the excellent over-all quality of this grain. Wheats of lower protein content might be more sensitive to the damaging effects of irradiation, particularly with dosages beyond 250,000 rep.

These results throw light on certain unexplained effects observed by Brownell *et al. (3)* in their evaluation of irradiation treatment of cake and all-purpose flour. The dryer texture, which they noted in heavily irradiated cake flour along with an increased need for liquid in making batters or doughs, is readily explained on the basis of damage to the starch fraction observed in this study. The increased sweetness of cakes made from flour treated at high irradiation levels might be a reflection of increased sugar production due to the apparent increase in starch susceptibility to amylase action noted in this work.

The present data, considered along with those of the previous paper *(6)*, suggest that *minimum* irradiation levels lethal to fungi responsible for heating and biochemical deterioration of stored grain (125,000 to 650,000 rep) are not damaging to breadmaking quality and indeed that the lower level of this irradiation range may cause an improvement in bread quality comparable to that produced by potassium bromate.

SUMMARY

Gamma irradiation of high quality hard red winter wheat in a dosage range lethal to insects and to fungal respiration (125,000 to 1,000,000 rep) caused decreases in germination but no immediate change in fat acidity, protein solubility, or fluorescence of acid extracts of the grain. Flour milled from such wheat showed regular decreases in gluten imbibitional capacity and stimulation of autolytic sugar production. Drastic reduction in starch gelatinization viscosity occurred with increased radiation treatment. Irradiation of wheat caused doughs to become stiffer and less extensible, and increased their tendency to break down with overmixing. Bread quality, assayed by commercial procedures, appeared to be improved by the 125,000 rep treatment but higher dosages produced inferior results. The effect noted is analogous to that produced by potassium bromate.

Acknowledgments

The cooperation of Dr. Bruce M. Morgan and his associates of the Radiation Sterilization Project, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill., in arranging for irradiation treatment of the grain used in this study is sincerely appreciated.

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The Effect of Ionizing Radiations on Sprout Prevention and Chemical Composition of Potatoes[a]

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ON THE BASIS of an average yearly consumption per person of more than 100 pounds, potatoes can be considered one of the most important staples in the American diet. Potatoes are also, in certain geographical regions, one of the farmer's chief cash crops. Proposed methods for reducing losses, for example, the application of ionizing radiations to prevent sprouting, are therefore well worth evaluation and study.

Proximate composition of potatoes, according to Lee *(18)*, is given as 77.8% water, 2.0% protein, 0.1% fat, 0.99% ash, and 19.1% total carbohydrates. The greatest amount of the latter is found in the form of starch; but sucrose and reducing sugars also occur. Considerable emphasis has been placed on the determination of the specific gravity of the potato. This can be rapidly determined by weighing a known amount in air and, subsequently, fully immersed in water. By this simple procedure an excellent index of the total solids present and the mealiness of the potato after cooking can be obtained. The higher the specific gravity the less soggy and the more mealy the potato is.

Of 16 varieties of the 1955 potato crop grown in 9 different Pennsylvania counties, average specific gravity for the individual varieties ranged between 1.055 and 1.073, whereas the extreme single values varied between 1.0362 and 1.0980 *(23)*. Many factors influence specific gravity. Among them may be mentioned variety, geographical location, altitude, condition of the soil, and growing conditions.

Hindhede *(13)*—an outspoken proponent and advocate of a low protein intake as well as a strict vegetarian—has reported some very interesting results obtained from human feeding experiments. He demonstrated in 1913 in experiments covering almost 300 days that a positive nitrogen balance could be obtained in man on a diet of potatoes alone and with small supplements of margarine. This was proof of the high utilization and nutritional value of the potato in the human dietary. Although much more recent experiments have shown that potato proteins are lower in both lysine and methionine than high quality animal proteins, the nutritional value is still considered to be very high, not least because of the high ascorbic acid content. More recent experiments by Kon and Klein *(17)* have further confirmed that potatoes plus a small amount of fat can keep human subjects in a positive nitrogen balance for a period of 167 days.

Even though potatoes are in a more or less dormant stage during the first weeks of storage, the metabolic activities continue throughout storage as indicated by the evolution of carbon dioxide. The metabolic activity is dependent upon the storage temperature. For this reason cognizance must be taken of the fact that the higher the storage temperature the higher the metabolism and, consequently, the greater the potential loss of nutrients during storage. According to Burke *(3)* "ten times as much carbon dioxide is given off at 113° F. as at 50° F." On the basis of nutrient loss, therefore, a storage temperature just above freezing should be the most advantageous.

It is generally accepted that for most potato varieties a storage temperature below 40° F. favors a shift to the right in the equilibrium reaction, starch $\rightleftharpoons$ sugars; whereas a temperature of 50° F. or above favors a shift to the left with a resynthesis of starch from sugar. Small quantities of utilizable and transportable sugar are required in the metabolism of the potato tuber; but an excess of sugars is not desirable because they impart a sweet taste thereby lowering the acceptability for cooking purposes as well as for the manufacture of potato chips. If an adequate and accurate temperature control could be made available, it would be possible to store potatoes at 40° F. and then increase the storage temperature to 50° F. a week or two before consumption or sale. Storage temperature management of this type would assure a taste quality that might satisfy the discriminating human palate and at the same time meet the requirements of the potato chipper. But it would also significantly complicate storage problems. As far as is known it has not been demonstrated that the presence of a plethora of sugars leads to a luxus consumption of same on the part of the potato.

Weight losses during prolonged potato storage are considerable and may amount to 20% after extensive sprouting and shriveling have taken place. A loss of 5% is common under ordinary storage conditions. The greatest portion of this weight loss is due to a water loss through transpiration. Transpiration is influenced by the relative humidity of the ambient storage air and, in the case of excessive sprouting, to the loss of solids and water associated with the formation of new proliferative sprout tissue. The inedible sprouts contain a basic glucoside solanine which is poisonous; hence in such cases the sustained nutrient losses include those ascribable to the sprouts themselves and those normally used in the metabolism of the tuber. This latter loss may in general be assumed to be minimal although the tuber metabolism is significantly increased prior to and during sprouting.

During prolonged potato storage a number of undesirable changes may and do occur which lead to financial losses. Chemical treatment of seed tubers and foliar spraying of the potato vines during the growing

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season have markedly decreased such losses. It is proposed to limit this discussion to the use of chemical compounds and ionizing radiations for the inhibition of sprouting and the possible effect upon the composition of the potato.

Pentzer and Heinze *(24)* have described post-harvest physiology of fruits and vegetables in a recent review which indicates that very complex and only partially known factors are involved. For the control of sprouting by chemical treatment a number of compounds have been used, among which the following may be mentioned: esters of naphthalene acetic acid, esters of trichlorophenoxy acetic acid, 3 chloroisopropyl-N-phenyl carbamate, 2, 3, 5, 6 tetrachloronitrobenzene, and maleic hydrazide. Relative to the latter compound Ezell and Wilcox *(10)* have reported that pre-harvest spraying of sweet potatoes resulted in the appearance of black pock marks on the tubers after harvesting. In a recent bulletin *(15)* experiments with maleic hydrazide have definitely shown that this anti-sprouting agent also had an effect on the respiration of potato homogenates. A stimulation of both oxygen uptake and carbon dioxide formation was observed with low concentrations reaching a maximum on the curve with a 2000 p.p.m. At a concentration of 4000 p.p.m. the stimulatory and inhibitive effect on respiration appeared to be counterbalanced.

Changes in the chemical composition of potatoes have long been known to be influenced by temperature. Hopkins in 1924 *(14)* observed an accumulation of both sucrose and reducing sugars after storage at low temperatures. An increase in sucrose has also been reported by Denny *(8)* after treatment with thiourea, ethylene chlorhydrin, and thiocyanate. Since then many other chemical compounds have been studied by other investigators.

The normal presence of sucrose in potatoes has been an accepted fact for years; but the formation and function of sucrose have not been completely elucidated. Normally, the beta amylase present in the potato hydrolyzes starch to dextrins and maltose and phosphorylase breaks starch down into glucose-1-phosphate. However, another enzyme, phosphohexoisomerase, is believed to control the equilibrium between glucose-6-phosphate and fructose-6-phosphate, both being necessary for sucrose synthesis. Arreguin-Lozano and Bonner *(19)* have discussed the sucrose synthesis and the enzymes concerned and Schwimmer *(26)* in a very extensive review with 110 appended references has considered all the enzyme systems present in the white potato.

Ellison and Cunningham *(9)* have reported an increase in dry rot in tubers treated with the methyl ester of α naphthalene acetic acid; but sprouting was inhibited. Relative to the use of maleic hydrazide as an anti-sprouting agent, some investigations have indicated that this compound, used as a foliar spray, tended to diminish the reducing sugars. This observation was not confirmed by Highlands *et al. (12)* who found no significant difference in reducing sugars between untreated and treated samples of Katahdin and Kennebec varieties stored at 40° F. for 6 months. However, Payne and Fults *(22)* more recently have reported a statistical difference in reducing sugars after early treatment with maleic hydrazide and 2-4-D. Concerning the concentration of reducing sugars present in tubers, it is to be borne in mind that Watada and Kunkel *(32)* have found considerable differences in 54 varieties investigated. Guzman-Barron *(2)* has shown that the respiratory quotient for fresh sliced potatoes is 1.0, indicating complete carbohydrate oxidation. This demonstrates the need for a constant supply of sugars in potato metabolism.

A series of studies on microbic respiration was conducted 30 years ago by the famous bacteriologist at the University of Michigan, Dr. F. G. Novy. In 1925 *(21)* his son employed the Novy respirometer to respiration studies on fresh, aseptically removed, potato slices and observed the development of a negative pressure of —10 mm. in the previously calibrated apparatus after 19 hours at 31° C. Subsequently, the pressure increased with time indicating at first an uptake of oxygen followed by an accumulation of carbon dioxide. In early 1953 *(16)* experiments on raw canned carrots, exposed to large dosages of gamma radiation, resulted in a great gas pressure within the can after 4 days at room temperature. By a careful transfer to a gas analyzer carbon dioxide was determined. In later experiments single Idaho potatoes were irradiated and cylinder samples removed aseptically and transferred to the Novy respirometer where the gas pressure was recorded at regular intervals during storage at 37° C. Observations showed definitely that there was little or no negative pressure developed in samples exposed to gamma radiation dosages between 2.5×10^5 and 2.0×10^6 rep. For a dosage of 2.5×10^5 rep a plot of gas pressure versus storage time gave almost a straight line up to 180 mm. after which the curve flattened out. Irradiation with 2.0×10^6 rep evidently has an effect on the respiratory enzyme of the potato because only low pressures could be obtained. In addition, the irradiated samples darkened progressively in color with time, whereas nontreated controls retained their normal appearance. Sussman *(30)* has reported some very significant experiments on the respiration in potatoes before and after gamma irradiation. Freshly harvested Irish Cobblers were exposed to dosages between 1.0×10^2 to 3.2×10^6 rep gamma radiation and the respiratory exchange determined in a modified Warburg apparatus. A great increase in oxygen uptake, up to sixfold, was observed early in the experiments, then followed a decrease after the first day. On the other hand, carbon dioxide production reached a maximum somewhat later than that for oxygen. Subsequently, the decrease in both oxygen and carbon dioxide was approximately parallel. Sussman *(30)* also observed a darkening of color of the potato, especially after the higher dosages, which would indicate drastic metabolic changes. In recent experiments Roberts and Proctor *(25)* have shown that cathode dosages of 2.0×10^6 to 3.0×10^6 rep changed the middle lamellae of potato tubers, presumably due to alteration of calcium pectate and pectinaceous material in the cell wall. Waggoner *(31)* has also shown that sprout inhibiting dosages in the range

of 2.0 to 8.0 x 10^4 rep do not increase resistance to infections by bacteria.

It has been shown *(25)* that changes occurred in the middle lamellae of potatoes, but without breaking the cell wall, after 2.0-3.0 x 10^6 rep irradiation. Irradiation with *sterilizing* dosages may cause textural changes in fruits and vegetables with the extent of change being related to the magnitude of the applied dosage. The thinner and less substantial the surface covering is, the lower the minimum damaging dosage may be. On this assumption, a dosage that might adversely affect the skin of fresh cherries might not produce changes visible to the naked eye when applied to the more substantial potato peel. Proof of textural changes in the potato peel have not been observed after dosages which *inhibit* sprouting.

Suberization, the process of laying down, for protective purposes, of cells high in suberin, is of interest in connection with irradiation of potatoes since it is a naturally occurring protective mechanism of the potato. There should be in the normal course of biochemical events, an increase in suberin if damage has occurred from irradiation. An increase in suberin should be demonstrable by microtonic technique and staining with a Sudan dye. Further, if a suberized layer is formed after irradiation, then there should be a decrease in water loss by transpiration owing to decreased permeability. Further proof of textural changes should be obtainable by determining the firmness or softening of control and irradiated potatoes. A distinction should perhaps be made here between the actual softening of representative, cylindrical samples bored out of the potato and the effect of irradiation on the potato peel itself. It is also to be borne in mind that irradiation is a foreign stimulus and that the immediate response of the irradiated tuber might result in an initial strengthening of the tissue, followed by a subsequent weakening of the tissue. If irradiation has caused damage to the potato surface, an increase in the incidence of diseases due to pathogenic microorganisms could be expected. The effect of irradiation on slight wounds already present in the potato is another aspect of the role of suberization that appears not to have been extensively studied.

Observations made on control and irradiated potatoes in the experiments to be reported did not indicate any increased susceptibility to attack by pathogenic microorganisms, and the apparent loss of water by transpiration during storage remained essentially the same for both control and irradiated potatoes. Unfortunately, equipment was not available for histological studies and the determination of firmness of the potato tissue before and after irradiation.

EXPERIMENTAL AND RESULTS

Pioneer experiments by Sparrow and Christensen *(28, 29)* have demonstrated that sprouting of potatoes could be diminished after irradiation with 5.0 x 10^5 rep and completely inhibited after 2.0 x 10^4 rep for a period of 18 months at a storage temperature of 5-7° C. The potatoes (Katahdin) also remained firm in texture, the weight loss during storage was reduced, and the acceptance was not diminished by a 2.0 x 10^4 rep dosage. The possible practical application of these results lead to the planning of a series of investigations at the Fission Products Laboratory, University of Michigan, in which the effect of gamma radiation was studied on Minnesota grown Irish Cobblers relative to anti-sprouting effect and food acceptance *(4)*. Complete details have previously been reported *(4,5)*; hence this description will be limited to essentials needed for clarity. The experiments began in January 1954 when Irish Cobbler potatoes were exposed to 0, 7.0 x 10^3, 2.1 x 10^4, and 2.8 x 10^4 rep dosages (Co. 60) after which they were stored in unsealed, perforated polyethylene bags at 50° F. and 50% relative humidity. Intensive sprouting occurred in non-irradiated control potatoes already after 3 weeks' storage and increased with time up to 5½ months when the experiments were discontinued because of intense sprouting, spoilage, development of black heart, and poor texture in the controls. Limited sprouting developed in potatoes exposed to 7.0 x 10^3 rep; but not after the higher dosages. The results from the taste panel tests, in which the potatoes were ranked by means of paired comparisons, indicated no preference for the controls over irradiated potatoes in 20 sittings. However, the observation was made that the potatoes exposed to 2.1 x 10^4 and 2.8 x 10^4 rep had a sweeter taste than the controls. On the basis of the results obtained in these experiments, it was believed that the optimum irradiation dosage would be between 7.0 x 10^3 and 2.1 x 10^4 rep.

As far as was known at the time (1954), data on the effect of gamma radiation on the chemical composition of the potato had not appeared in public print *(5)*. For that reason, it was deemed to be of interest to investigate the possible effects of gamma irradiation on the concentration of sucrose and reducing sugars at a definite period after storage. On account of the fact that the decision to include chemical determinations was made during the summer, the Minnesota-grown Irish Cobbler had to be used for this purpose. Six potatoes per sample were pooled and the analytical procedure followed was the official method *(1)* in a slightly modified form to permit the use of a prepared potato slurry in lieu of dried samples *(11)*. The reducing sugars present were determined, before and after incubation with invertase, according to Somogyi *(27)* with some modifications. Sucrose was calculated from the difference in reducing sugars before and after incubation with invertase. Duplicates were taken from all potato slurries and the sugars on these duplicates run in triplicates. The first set of a very limited number of determinations represents quantities present after 6 months of storage, not the immediate effect of gamma radiation.

TABLE 1

Comparative analytical data for reducing sugars before and after incubation with invertase from non-irradiated and irradiated raw Minnesota grown Irish Cobbler potatoes stored at 50° F. and 50% relative humidity since January 1954

Date of determination	Treatment rep	Reducing sugar %		Sucrose % by difference
		Before incubation	After incubation	
15 July	Control	1.89	2.93	0.99
17 July	7.0 x 10^3	1.22	1.82	0.57
21 July	2.1 x 10^4	1.30	1.55	0.23
12 July	2.8 x 10^4	1.39	1.87	0.45
26 July	Control	1.64	2.00	0.32
Average	2 Controls	1.77	2.47	0.65
Average	3 Irradiated	1.30	1.75	0.42
	Numerical	0.47	0.72	0.23
Difference	%	26.6	29.1	35.4

Since these limited data indicate a difference in sugar concentrations between non-irradiated controls and irradiated potatoes after 6 months of storage, it was decided to investigate the more immediate effect of irradiation on potatoes. That very drastic changes occur has been demonstrated on the basis of increased respiratory exchange *(16, 30)*. Such a stimulation in the irradiated potato must of necessity require additional utilizable sugars for the increased metabolism; therefore, the normal equilibrium starch ⇌ sugars must at least temporarily be altered with the utilization of sugars. This could result either in a lower concentration of sugars or an increased enzymatic breakdown

of the starch molecule. Possibly the one would counteract the other.

For the second set of experiments a 100-pound bag of Idaho potatoes of the 1953 crop was purchased in May 1954 and stored without irradiation at 50° F. and 50% relative humidity. The sugars were determined as described in the preceding section. Sussman *(30)* did not present intermediate points during the first 24 hours and thus did not show the immediate effect of irradiation. In order to determine the effect of irradiation as quickly as possible, 6 representative non-irradiated potatoes were removed from storage at appropriate times and, except for the controls, irradiated with 1.0×10^4 rep during a period of 60 minutes. The long exposure time was considered necessary for accuracy of dosage because of the intensity of the Co 60 source. The zero hour of standing after irradiation was taken to be the time after completing the irradiation although the enzymatic activity might have continued until approximately 2 hours later when the alcoholic extract was placed on the steam bath. In view of the minor changes during the first few hours after irradiation, this may not have been of great importance. These determinations were run between late September and early November 1954 when the writer changed positions.

The data are presented in Table 2 and plotted in Figure 1.

TABLE 2

Quantitative data showing content of reducing sugars before and after incubation with invertase in non-irradiated and irradiated raw Idaho potatoes stored at 50° F. and 50% humidity since May 1954

Treatment rep	Hours of standing	Reducing sugar %		Sucrose % by difference
		Before incubation	After incubation	
Control	0	0.85	0.96	0.10
10,000	0	0.73	0.75	0.02
10,000	0	0.76	0.76	0.00
10,000	1	0.80	0.82	0.02
10,000	3.5	0.72	0.74	0.02
10,000	5	0.90	0.93	0.03
10,000	15	1.15	1.22	0.07
10,000	25	1.43	1.51	0.07
10,000	48	1.40	1.53	0.12
10,000	72	1.39	1.50	0.10

DISCUSSION

It can be seen from Figure 1 that relative minor changes in sugar concentrations occur during the first few hours. After an initial decline the values return after 5 hours to the approximate original figures; then to be followed by a significant increase with an apparent maximum after 24 hours. Subsequently, the curve flattens out without significant changes to 72 hours. Unfortunately, time did not permit further determinations despite the fact that it would have been interesting to have obtained additional data to complete the curve. It is repeated that these experiments were performed with potatoes which had long been in storage and it may, therefore, be inappropriate to assume that similar changes would occur with fresh potatoes. However, the observed effect is definite.

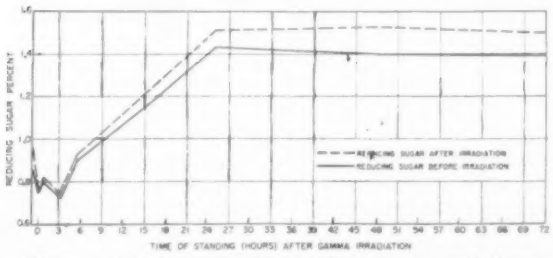
REDUCING SUGAR PERCENT
TIME OF STANDING (HOURS) AFTER GAMMA IRRADIATION
REDUCING SUGAR AFTER IRRADIATION
REDUCING SUGAR BEFORE IRRADIATION

Figure 1. The influence of 1.0×10^4 rep gamma radiation on the content of reducing sugar in raw Idaho potatoes.

A speculative interpretation of the data might indicate an almost immediate effect on the potato by exposure to gamma radiation. This is supported by the initial decrease in sugar concentration. On the supposition that the metabolism of the potato is markedly increased either immediately or shortly after gamma radiation, there should be a corresponding increased requirement for sugars with the result that the prevailing sugar concentration decreases. After a few hours the equilibrium starch $\rightleftarrows$ sugar is altered as a result of the increased requirement for sugar by the potato and in order to reestablish the former equilibrium, the potato responds by increasing the enzymatic breakdown of starch into sugars. The possibility also exists that gamma radiation directly stimulates the enzymatic hydrolysis of starch.

The experiments may be summarized by stating that a gamma ray dosage between 7.0×10^3 and 2.1×10^4 rep definitely inhibits sprouting in potatoes during storage. A dosage of 1.0×10^4 rep definitely increases the reducing sugar concentration in Idaho potatoes.

The writer is well aware of the fact that Federally sponsored research on the effect of ionizing radiations on potatoes is now being pursued at several educational institutions. These studies presumably involve both chemical changes in the potato itself, as determined by direct analysis, or indirectly in animal feeding experiments. The results from these studies, as far as is known at this time of writing, have not appeared in public print.

The peacetime applications of atomic energy in the form of gamma radiation have been widely discussed and are presently being studied in many laboratories under Government grants. Releases to the press and a few scientific articles have stressed the growing importance of this most recent method for the sterilization of foods. However, it may be well to consider two recently expressed views which bring the practical and feasible applications to industry and commerce into a clearer and more definite perspective.

The future of food preservation by ionizing radiations has been stated in the McKinney Report *(20)* as follows: "Radiation preservation of food does not appear likely to replace other methods to any substantial extent in the foreseeable future. When economically feasible, it would be a supplement to other methods." The past president of the Institute of Food Technology, Dr. L. E. Clifcorn *(7)*, has reviewed the potential of the radiation treatment of foods. On the basis of progress made during the past 15 years in the field of radiation sterilization of foods—a field of research which has chiefly been sponsored by the U. S. Government—future applications, according to Dr. Clifcorn *(7)*, most probably will be in the form of combination treatments which will supplement rather than displace the conventional methods now in use. One of the contributions cited by Dr. Clifcorn is the inhibition of sprouting in potatoes.

Perhaps the more immediate practical application of gamma radiations to the food industry might be in the

form of a partial pasteurization by means of which the shelf life of many food items have been materially increased without at the same time imparting undesirable sensory changes which may and do occur when sterilizing dosages are applied. The possible practical application of preventing sprouting in potatoes on a commercial scale by gamma radiations has been presented by Brownell *et al. (6)* in the form of a design for a radiation facility, complete with estimated construction and operational cost data.

The commercial applications of sterilization of foods by gamma irradiation beyond experimental pilot studies must await final approval of irradiated foods by the Food and Drug Administration. Even after approval has been obtained, cognizance must be taken of the important fact that the American housewife is naturally very reluctant to accept new methods in food preservation quickly because of her responsibility for feeding those under her care. It will undoubtedly require a prolonged and intense sales campaign to convince her.

CONCLUSION

In conclusion it can be stated that the original observations of Sparrow and Christensen on the anti-sprouting effect of small dosages of gamma radiation on potatoes have been confirmed. The small dosages required for this particular purpose do not produce undesirable sensory changes in the potato on the basis of findings by an expert taste panel. A gamma radiation dosage of 1.0×10^4 rep produces significant immediate changes in reducing sugar concentrations of storage potatoes. It is not known in which manner the anti-sprouting effect is exerted. The nature, function, and importance of changes in carbohydrate components are likewise unknown.

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The Effect of Intermittent Radiations and Concomitant Increase in Temperature During Radiation on the Acceptability Of Ground Beef[a, b, c]

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USE OF IONIZING RADIATIONS as a new method of food preservation has been under intensive study through the sponsorship of the Quartermaster Food and Container Institute for the Armed Forces. Ultimate objective of the basic project is to develop a method of submitting foodstuffs to radiations which will provide an acceptable and adequately preserved food for military feeding.

Use of electromagnetic radiations as applied to problems in food technology has been extensively reviewed by Proctor and Goldblith *(9)* and Hannan *(3)*. Kelner, Bellamy, Stapleton, and Zelle *(6)* have recently reviewed the effects of such radiations on bacteria. Morgan and Reed *(7)* submitted a suspension of T.A. 3814 spores to 0.2 and 0.6 megarep prior to heating the suspension to 240° F. They found this procedure to be more effective in killing the spores than if the reverse method were employed. Wood *(13)* reported that the sensitivity of *Saccharomyces cerevisiae* to X-rays increased between the range of —30° C. and 0° C. At temperatures of about 50° C. the sensitivity to radiation damage increased several fold.

Hannan *(3)* also pointed out the possible advantage of pulsed beams of high energy electrons over a continuous exposure to gamma radiations at low dose rates. He offers an explanation for this in that through the use of such pulsations possible chain reactions set up by the initial ionization would be broken.

It appeared desirable to determine (a) the influence of intermittent gamma irradiation and (b) the influence of gamma irradiation while the product was at specific temperatures on the acceptability of ground beef. This investigation has centered on the effects of these methods of irradiation on the bacterial population, peroxide formation, thiobarbituric acid color formation, fluorescence value and flavor of ground beef.

MATERIALS AND METHODS

The beef used in these experiments was obtained freshly ground and consisted of approximately 85% lean and 15% fat. The meat was filled into No. 2 (307 x 409) cans, sealed under vacuum, frozen and shipped to the Materials Testing Reactor, Arco, Idaho, where the cans were exposed to intermittent gamma radiation and to the Dugway Proving Ground, Utah, for irradiation at specified temperatures. Shipment to and from the radiation sites was with dry ice. The meat was kept frozen until thawed for subsequent chemical, bacteriological, and flavor analysis.

Irradiation Treatments

I. Intermittent Radiation Experiment

The meat was thawed 12 hours at 70° F. and then exposed to ionizing radiations. The mixed ionizing ray flux was held constant at 1.27×10^6 r/hr. for all treatments. The treatments included in this series were as follows:

1. Treatment 1 was exposed to the gamma ray flux for a single period of 1 hour and 35 minutes. The total dose and time of exposure was 2.01×10^6 rep and 95 minutes, respectively.

2. Treatment 2 was exposed for two periods of 47 minutes and 30 seconds each. The cans of meat were held at 70° F. for 4 hours during the non-irradiation period. The total dose and total time of exposure was the same as in Treatment 1.

3. Treatment 4 was exposed for four periods of 23 minutes and 45 seconds each. During each non-irradiation period the meat was held at 70° F. for 4 hours. The total dose and exposure time was the same as in Treatment 1.

4. Treatment 8 was exposed to the radiations for eight periods of 11 minutes and 53 seconds each. Between irradiation periods the cans of meat were held as stated for Treatments 2 and 4. The total dose and exposure time was identical to that of Treatment 1.

II. Temperature During Irradiation Experiment

Upon receipt of the meat at the Dugway Proving Grounds, the cans were conditioned to 0°, 32°, 64°, 96°, 128°, and 150° F., the maximum temperature available, prior to irradiation. Irradiation was accomplished at these temperatures. The gamma dosage employed was 0.5, 1.0, 1.5, and 2.0 megarep. The control cans received no irradiation, but were conditioned to temperature. Sufficient cans of meat were irradiated at each temperature-irradiation level to provide for subsequent examinations. The time intervals necessary to condition the cans to the specified pre-irradiation temperatures, in an oven at 175° F., and to irradiate them to the required dosage were as follows:

Temperature ° F.	Time (hrs.: min.)	Dosage megarep	Time (hrs.: min.)
0	.....	0	.....
32	2:50	0.5	0:41
64	3:05	1.0	1:21
96	3:55	1.5	2:00
128	4:30	2.0	2:40
150	5:50		

Flavor analysis. The cans of meat were thawed overnight at room temperature. The meat was formed into patties, broiled for 8 minutes on each side, and served to the panel in randomly numbered serving cups. Fourteen and sixteen experienced judges comprised the panel for the intermittent and temperature-irradiation experiments respectively. The judges were seated in isolated booths, lighted by an amber light.

In the intermittent irradiation experiment the judges were presented with 4 samples, each representing one of the treat-

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 13, 1956.

[b] Technical Paper No. 973, Oregon Agricultural Experiment Station Contribution of the Departments of Food Technology, Agricultural Chemistry and Bacteriology.

[c] This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 649 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

ments. A reference sample identical with that of Treatment 1 was also provided and the separate treatments scored against the reference. Four replicated panel judgments were obtained.

In the temperature-irradiation experiment the judges scored each sample once. Five treatments (combination temperature-irradiation dosage) was scored at each sitting. A reference sample, identical with that of the 0° F.-1 megarep treatment, was provided and the separate treatments scored against it.

The judges scored each treatment against the reference for intensity of irradiated flavor on a 5-inch line ballot. One end of the line was marked "No Irradiated Flavor" and the other "Extreme Irradiated Flavor." These were scored at 5 and 0 respectively on a linear scale. The position of the reference sample with respect to the extremities of the scale was shown at the 3-inch mark. No scores appeared on the ballot. The ballots were decoded, scored, and later subjected to analysis of variance.

Bacteriological analysis. The irradiated meat samples were opened aseptically and 10 g. transferred to a sterile blender and mixed for 1 to 2 minutes with 100 ml. of sterile water. Five ml. of the homogenate was plated in tryptone, glucose, yeast extract, (TGY) agar, incubated at 86° F. for 72 to 96 hours and the plates were examined for colonies of surviving organisms. Each analysis was made on a randomly selected can from each treatment. The bacteriological analyses were run in triplicate.

Chemical analysis. The classical method for the determination of oxidation in lipid material has been the peroxide number. In recent years the reaction of oxidized fat with thiobarbituric acid has been shown to produce a characteristic color *(2, 8)*. This production of color has been correlated with acceptance on several products *(11, 12)*. These two tests and the rise in fluorescence have been applied to these irradiated products.

Thiobarbituric acid assay. A solution containing 0.1M (1.27 g.) of TBA and 15 g. of trichloroacetic acid, made up to 100 ml., was used as the reagent.

The sample of food to be assayed was weighed directly into a 150 ml. centrifuge tube. For each 10 g. of food, 20 ml. of the TBA reagent was added. The resulting mixture was heated in a boiling water bath for 10 minutes with frequent and thorough stirring. The tubes and their contents were cooled quickly in a stream of cold water or an ice bath. The cooled mixture was centrifuged and the percent transmission of the colored supernatant liquid read in a B & L. colorimeter at 535 mμ. The results were expressed as percent transmission at that wave length.

Peroxide number. The peroxide number was based on the procedure of Hartman *(5)* and was determined from cold dehydrated benzene extracts of the meat samples. A standard curve of benzoyl peroxide was used for calculations. The results were expressed as mgs. of benzoyl peroxide per gram of fat.

Fluorescent values. Ten grams of chloroform defatted meat were twice extracted with 20 ml. of 0.6% sodium chloride solution. The two extracts were read on the Coleman fluorophotometer using the B_1 filter. The obtained readings were added together and reported as a single value. 0.5 N quinine sulfate was used as the standard.

RESULTS AND DISCUSSION

I. Intermittent Radiation Experiment

Flavor Analysis. Results of the analysis of variance of the experiment on the effect on flavor of ground beef after 1, 2, 4, and 8 exposures to gamma radiation are presented in Table 1. It may be seen that the treatments were significant when tested against the taster by treatment interaction, which is the agreement of the tasters with reference to the differences in the samples.

The mean flavor scores of the 4 treatments are shown in Table 2. In addition the time of handling each of the treatments from the initial to the final irradiation is given. It may be seen that the only treatment which resulted in a significant diminution of the irradiated flavor was Treatment 8. That this would not be a workable system in irradiation of meats, under the conditions of this experiment, may be seen by reference to the number of hours involved for the eight exposure treatment. It may be possible that repeated exposures to short bursts of ionizing radiations with much less time interval between irradiations may accomplish the same effect, that of diminishing the irradiated flavor.

TABLE 1
Analysis of variance of flavor scores as affected by intermittent irradiation of ground beef

Factor	df	Mean square	F ratio	Significance
Total	223	0.764		
Replications (R)	3	1.046	0.47	.....
Tasters (T)	13	3.995	1.79	.....
R x T	39	2.224	4.70	at P .01
Treatments (IR)	3	1.967	4.01	at P .05
T x IR (Error)	39	0.465		
Residual	126	0.473		

TABLE 2
Mean flavor scores and time of irradiating ground beef exposed to intermittent irradiation periods

Treatment and number of exposures	Mean flavor scores	Total time of processing (hrs.:min.)
1	3.21	1:35
2	3.23	5:35
4	3.23	13:35
8	3.60	29:35

Least significant difference (5%) = 0.26 flavor units.

Bacteriological Analysis. The samples of meat used in these experiments were contaminated with a natural heterogeneous flora of microorganisms approximating 8.3×10^5 per gram. This number included the radiation resistant species *(1)* which numbered from 500 to 1,000 per gram. The number of surviving organisms per gram following the intermittent radiation treatments is shown in Table 3.

TABLE 3
Number of surviving organisms per gram after exposure to intermittent irradiation (Control 8.3×10^5)

Number of exposures	Dosage (megarep)	
	1	2
1	604	13
2	303	12
4	133	2
8	.....	2

These results indicate that there was no survival of non-radiation resistant bacteria after exposures of 1 megarep. There was a diminution in numbers of radiation resistant bacteria surviving with increasing numbers of intermittent exposures, although the accumulated dosage remained constant. It appears that with each successive exposure the total numbers of surviving organisms were reduced by approximately one half. Previous experiments have shown that the resistance of these organisms varies with the age of the culture. The younger cells are destroyed at a lower radiation level. It is possible that during the holding period of 70° F. for 4 hours and during irradiation when the cells would continue to reproduce they pass through a period of physiological youth and thus are

easily destroyed by irradiation. Samples irradiated at the 2 megarep level showed similar results; however, the limited numbers surviving do not permit a definite conclusion to be drawn.

Chemical Analysis. A total of 30 cans were analyzed for their TBA value and peroxide content. Although the values of the cans receiving doses of less than 2 megarep gave a pattern difficult to interpret, those receiving 2 megarep showed a definite trend in one direction. These data are shown in Table 4.

TABLE 4
Peroxide number and TBA value of ground beef after exposure to intermittent gamma irradiation

Number of exposures to receive 2 megarep	Peroxide number	TBA value
1	0.849	70
2	1.045	74
4	0.397	80
8	0.112	87

It can be seen from these data that less oxidation occurred when the total dose was given in increments. These data can be interpreted as the result of the breaking of the chain reaction. The pauses in the irradiation dose (4 hours) are apparently sufficient to cause the free radicals to dissipate before additional irradiation energy can increase their level.

II. Temperature During Irradiation Experiment

Flavor Analysis. The results of the analysis of variance on flavor scores of meat submitted while at specific temperatures to various dosages of ionizing radiations are presented in Table 5.

TABLE 5
Analysis of variance of flavor scores of ground beef as affected by temperature-gamma dosage variables

Factor	df	Mean square	F ratio	Significance
Total	479	.....	.....	
Tasters (T)	15	123.800		
Temperature (TE)	5	1.284	1.398	NS
Radiation (R)	4	18.405	12.666	P.01
Radiation (Linear)	1	65.000	106.382	P.01
Radiation (Quadratic)	1	8.686	14.216	P.01
Radiation (Remainder)	2	0.877	1.435	NS
T x TE	75	0.997	1.631	P.01
T x R	60	1.453	2.378	P.01
TE x R	20	1.024	1.675	P.05
T x TE x R	300	0.611		

It may be seen that there was a slight interaction between temperature and irradiation. The high number of degrees of freedom (20/300), made this effect statistically significant. The main effect on flavor of the ground beef was due to radiation as tested by the taster by irradiation interaction term. Irradiation of meat at temperatures of 0°, 32°, 64°, 96°, 128° and 150° F. had no effect on the development or intensity of the irradiated flavor. This confirms previous reports by this labaroatory *(10)* that irradiation is the most important single factor in reduction of flavor scores of meat so treated and that irradiation at 0° and 33° F. had no effect on the flavor scores. The mean flavor scores of the individual treatments and the grand means of the irradiation and temperature effect are shown in Table 6.

TABLE 6
Flavor scores of ground beef as affected by temperature and irradiation dosage

Dosage (megarep)	Temperature (° F.)						Irradiation dosage (means)
	0	32	64	96	128	150	
0	3.97	3.80	4.03	3.80	3.57	4.13	3.88
0.5	3.48	3.64	3.18	3.50	3.41	3.88	3.51
1.0	2.74	2.79	2.83	3.67	3.15	2.76	2.99
1.5	3.32	2.58	2.90	3.02	3.22	3.25	3.05
2.0	2.98	2.83	2.58	2.88	2.63	2.98	2.82
Temperature (Means)	2.93	2.78	2.76	3.00	2.84	3.02	

Temperature—No significant difference.
Irradiation—Significant at 1%. Least significant difference (1%) = 0.46.

The reduction in flavor score through the ranges of 0 to 1.0 megarep has a strong linear relationship. Dosages of 1.5 and 2.0 megarep then cause the flavor curve to level off and curve slightly upward in the direction of less irradiated flavor. The latter section of the curve, 1.5 and 2.0 megarep, show a quadratic effect with flavor scores changing less at high irradiation levels.

Bacteriological Analysis. Successive increases in radiation dosage levels with concomitant increases in temperature during the irradiation show decreasing radiation levels at which no viable bacteria can be recovered (Table 7). The effect of temperature began to manifest itself between 32° and 64° F. and increased until it alone was the sole cause of death.

The point at which irradiation and temperature have the most destructive action without visible product change due to heat was within the proximity of 96° F.

Chemical Analysis. Peroxide number, thiobarbituric acid value and fluorescent values were obtained on the 30 samples of meat. The results of these analyses are shown in Tables 8, 9, and 10. It can be seen from these tables that irradiation had marked effect upon the analytical values.

The peroxide numbers (Table 8) increased signifi-

TABLE 7
Number of organisms x 10^4 per gram in ground beef subjected concomitantly to variable gamma-dosage/temperature variables

Dosage (megarep)	Temperature (° F.)					
	0	32	64	96	128	150
0	390	400	300	109	17.8	0
0.5	0.95	0.10	0.06	0.09	0.008	0
1.0	0.07	0.07	0.04	0	0	0
1.5	0.06	0.004	0	0	0.0008	0
2.0	0.01	0	0	0	0	0

TABLE 8
Peroxide number of ground beef as affected by temperature and irradiation dosage

Dosage (megarep)	Temperature (° F.)						Irradiation dosage (means)
	0	32	64	96	128	150	
0	0	0	0	0	0	0	0
0.5	1.069	0.254	0.068	0.076	0.069	0.120	0.276
1.0	0.763	0.131	0.152	0.161	0.360	0.224	0.298
1.5	0.558	0.531	0.359	0.431	0.242	0.360	0.414
2.0	1.435	0.396	0.645	0.252	0.314	0.145	0.531
Temperature (Means)	0.765	0.262	0.245	0.184	0.197	0.170	

Temperature and irradiation significant at the 1% level.
L.S.D. (1%) Temperature = 0.39; Irradiation = 0.36.

cantly due to irradiation alone—there being no significant differences between specific radiation levels. Irradiation at 0° F. resulted in significantly more peroxides than at the other temperatures employed. This is in agreement with the report of Hannan *(4)* on butter fat irradiated in the molten state.

TABLE 9
Thiobarbituric acid values of ground beef as affected by temperature and irradiation dosage

Dosage (megarep)	Temperature (° F.)						Irradiation dosage (means)
	0	32	64	96	128	150	
0	68.8	61.3	63.5	65.5	63.7	64.5	64.6
0.5	19.8	51.4	59.0	59.0	57.3	67.6	52.4
1.0	20.5	37.9	40.1	58.6	57.3	66.0	46.7
1.5	20.8	32.9	32.7	37.0	40.3	54.3	37.7
2.0	21.1	27.8	33.8	38.5	55.8	67.5	40.8
Temperature (Means)	31.8	42.3	45.8	51.7	54.8	64.0	

Temperature and irradiation significant at the 1% level. L.S.D. (1%) Temperature = 16.8; Irradiation = 15.4.

TABLE 10
Fluorescence values of ground beef as affected by temperature and irradiation dosage

Dosage (megarep)	Temperature (° F.)						Irradiation dosage (means)
	0	32	64	96	128	150	
0	69.7	73.0	70.0	67.2	86.5	80.7	74.5
0.5	67.7	80.5	79.0	83.0	88.2	95.0	82.2
1.0	49.2	66.0	67.0	67.2	79.7	86.5	69.3
1.5	69.2	79.0	80.0	88.7	78.0	102.2	82.9
2.0	54.2	68.5	64.0	58.0	82.7	174.0	83.6
Temperature (Means)	62.5	73.4	72.0	72.9	83.1	107.7	

Irradiation N.S.D.; Temperature, significant at 5% level, L.S.D (5%) = 23.45.

A similar pattern was obtained for the TBA reaction. As the temperature during irradiation increased, the values (Table 9) approached that of the non-irradiated sample and at 150° F. most of the samples were in this range.

The values obtained for the fluorescence of the meat samples do not show a clear pattern or trend (Table 10). The irradiation dosage applied did not significantly change the obtained value over the irradiation dosages employed. Ground beef irradiated at 150° F. had significantly greater fluorescent value than if irradiated at lower temperatures.

The theoretical reason for the marked decrease in peroxide and TBA reactive products level is most likely a break in the chain reaction. The stability of the free radicals, which are part of the chain reaction, is lowered by the increase in temperature and this in turn shortens the life of the chain reaction.

SUMMARY

Ground beef exposed to intermittent gamma irradiation and to irradiation at progressively elevated temperatures was analyzed for peroxides, TBA, fluorescence, bacterial survival, and flavor.

Results indicated that in ground beef exposed to 1, 2, 4, and 8 exposure to gamma radiations:

1. Significantly less irradiation flavor developed in the eight exposure treatment.

2. Increase in number of exposures resulted in a significant decrease in survivors of a radio-resistant micrococcus.

3. A significant decrease in peroxides and TBA color occurred with increasing exposures.

When ground beef was exposed to increasing dosages of gamma radiations with concomitant increase in temperature, the results indicated that:

1. Irradiation flavor was dose dependent and independent of temperature.

2. Bacterial survival was dependent on both irradiation and temperature.

3. Peroxides and TBA color significantly decrease with increasing temperatures at the time of irradiation. Increasing levels of radiation resulted in significant increases in these values.

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Sweet Potato Processing. Pilot Scale Rotary Lye Peeler

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IN THE PREPARATION OF SWEET POTATOES for processing (canning, dehydrating, and freezing) a most important operation is the peeling and trimming of the raw product with minimum waste. Generally, one of the most widely used commercial methods involves the use of hot caustic solution to soften the peel and its subsequent removal by water washing. Additional trimming is done by hand.

Thurber and Bohne have described a plant scale rotary machine which effectively and economically peeled sweet potatoes, using hot caustic solution *(3)*. Later, Arthur *et al. (1, 2)* constructed a pilot scale rotary lye peeler, similar to the rotary machine of Thurber and Bohne *(3)*, for use in preparing sweet potatoes for dehydration.

Due to numerous requests for the details of construction of this pilot scale peeler, it is the purpose of this report to describe the peeler and its operation and to present representative data on its use.

EXPERIMENTAL

Rotary lye peeler. The peeler is essentially a rotary drum with pockets on its periphery. For pilot scale operations, this type of peeler offers the following advantages: (a) control of temperature of the lye solution by automatic regulation of steam flow in submerged coils; (b) control of time of contact of the sweet potatoes with the lye solution by regulation of the rate of revolution of the drum; (c) positive immersion of the sweet potatoes in the lye solution; (d) non-abrasive peeling; and (e) simplicity in construction and operation.

The peeler in operation is shown in Figure 1. A diagram of the peeler is given in Figure 2. In the construction of rotary

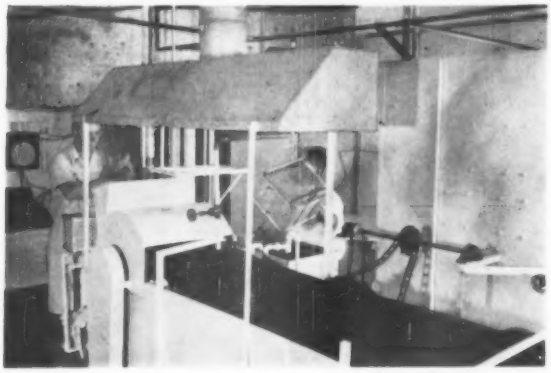

Figure 1. Pilot scale rotary lye peeler in operation.

drum B, 16-gage perforated and 10-gage sheet steel were used. Each pocket was fabricated from a piece of perforated sheet steel 9.7 by 18 inches; each piece was bent at a 120° angle, 2.6 inches from the edge of the 9.7-inch width; each of the 12 formed sheets was placed perpendicularly on a circular sheet of 10 gage sheet steel to make a rotary drum with 12 equally sized pockets and spot welded (part B, 12-inch radius). A ¾-inch shaft was welded onto each end of part B at its center; the shafts were fitted into steel pillar blocks resting on the angle iron rim of tank D. The drum B could then be rotated by any convenient means. Depending on rate of rotation, the capacity of the peeler for sweet potatoes ranges from 100 to 300 pounds per hour.

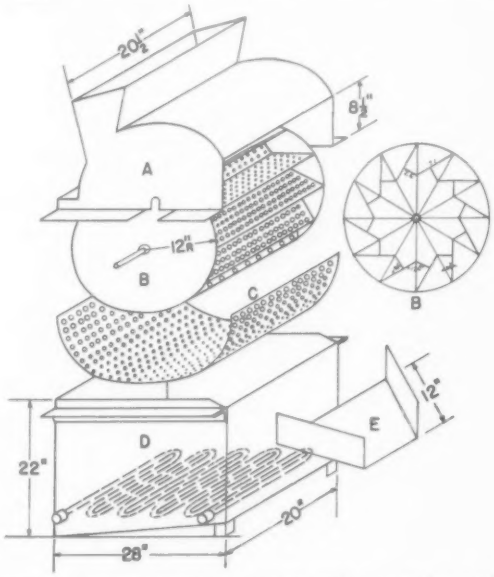

Figure 2. Construction view of pilot scale rotary lye peeler.

Tank D was constructed from 10-gage sheet steel. The steel steam coil (about 1 inch in diameter) was fitted into the bottom of tank D in any convenient manner, as shown. Although not necessary, it is advantageous to make tank D with a slightly inclined bottom with a drain opening at the lower side. This makes it simpler to clean the peeler. If desired, additional steel sleeves can be welded into the side of tank D to hold thermometers and thermoregulators. It is also desirable to have an overflow pipe near the top of the side of tank D to control the level of lye solution in the tank.

The curved baffle C, made from 16-gage perforated steel, was welded into tank D in such a manner that the baffle closely fitted (about ½ inch) rotary drum B when the drum was lowered in tank D for operation.

Cover A and discharge E were constructed from 10-gage sheet steel and fitted as shown in Figure 1.

Operation. Lye solution was prepared in a separate tank; then it was pumped into tank D of the peeler. The temperature of the solution was adjusted to the desired value by heating with steam (15 p.s.i.g.) passing through the coils. The rotation of drum B provided adequate mixing of the solution. About ⅓ of drum B was immersed in the lye solution and its rate of rotation determined the time of immersion of the sweet potatoes in the solution.

Sweet potatoes were introduced into the peeler from the top (Figure 1), conveyed through the lye solution, and dropped into a rotary washer where the softened peeling was removed. Washed, peeled potatoes were conveyed to a trimming table where ends and scar tissue were manually removed.

Materials. Sweet potatoes, grown in Louisiana during the 4 seasons from 1952-56 and harvested about the last of October,

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were cured for 10 days at 85° F. and 80 to 85% relative humidity and then stored at controlled temperatures, as indicated. Samples were periodically removed from storage to determine the effects of raw storage, variety, preheating, lye concentration, and size of the sweet potatoes on peeling and trimming losses.

RESULTS AND DISCUSSION

Effect of time and temperature of raw storage of Unit I Porto Rico sweet potatoes on peeling and trimming losses is given in Table 1. Losses are generally highest for potatoes stored at 50° F. and lowest for those stored at 60° F. The losses increased slightly with increase of time in storage.

TABLE 1
Effect of time and temperature of raw storage of Unit I Porto Rico sweet potatoes on peeling and trimming losses [1]

Storage of raw materials, months	Peel loss (raw), %	Trim loss (raw), %	Total loss (raw), %
0 days (fresh)	22	7	29
10 days (cured)	22	6	28
50° F.			
1	29	5	34
2	28	3	31
3	30	6	36
4	31	4	35
5	29	9	38
6	30	3	33
7	35	10	45
60° F.			
1	26	5	31
2	23	4	27
3	22	4	26
4	27	6	33
5	26	6	32
6	27	2	29
7	31	6	37
70-75° F.			
1	24	4	28
2	27	3	30
3	29	8	37
4	26	8	34
5	27	10	37
6	28	4	32

[1] Samples, 50 pounds; preheating by immersion in water, 30 minutes at 130° F.; lye concentration, 20%; temperature, 220° F.; time, 6 minutes. 1952-53 season.

TABLE 2
Effect of time in raw storage and of preheating of Unit I Porto Rico sweet potatoes on peeling and trimming losses [1]

Time in raw storage at 60° F., days	Preheating conditions in water		Trim loss (raw), %	Peel loss (raw), %	Total loss (raw), %
	Temp., ° F.	Time, min.			
66	130	30	7	34	41
70			4	27	31
71	165	10	6	23	29
72	130	30	7	30	37
73	165	10	7	28	35
77			6	35	41
78	165	10	8	28	36
79			6	26	32
80	130	30	7	29	36
100	165	10	7	20	27
105			5	24	29
106	130	30	11	26	37
107			6	25	31
108	130	30	8	22	30
113	165	10	7	25	32
114	130	30	9	28	37
115	165	10	8	28	36
119			5	28	33
121	130	30	7	30	37
122	165	10	7	28	35
126			8	28	36
127	165	10	7	30	37
128			7	28	35
129	130	30	7	29	36
133			7	26	33
134	130	30	8	30	38
135	165	10	6	29	35

[1] Samples, 60 pounds; lye concentration, 20%; temperature, 220° F.; time, 6 minutes. 1953-54 season.

Effect of time in raw storage at 60° F. and of preheating on peeling and trimming losses is given in Table 2. Losses are slightly higher for potatoes preheated in water for 30 minutes at 130° F. than for no preheating or preheating for 10 minutes at 165° F.

Effect of the size of Unit I Porto Rico sweet potatoes on peeling and trimming losses is given in Table 3, the larger the potato the less the peeling and trimming losses.

TABLE 3
Effect of size of Unit I Porto Rico sweet potatoes on peeling and trimming losses [1]

Number of potatoes in 50 pounds	Peel loss (raw), %	Trim loss (raw), %	Total loss (raw), %
58	21	2	23
127	27	4	31
231	34	5	39

[1] Samples, 50 pounds; raw storage, 90 days at 60° F.; preheating by immersion in water, 30 minutes at 130° F.; lye concentration, 20%; temperature, 220° F.; time, 6 minutes. 1955-56 season.

Variations in lye concentration from 10 to 20% and in preheating from none to 30 minutes at 130° F., for a peeling time of 6 minutes, did not significantly affect the total losses of Unit I Porto Rico sweet potatoes stored for 90 days at 60° F., as shown in Table 4.

Effect of variety and time in raw storage on peeling and trimming losses is given in Table 5. Trimming losses for the Goldrush variety are lowest, and these

TABLE 4
Effect of lye concentration and preheating on peeling and trimming losses [1]

Lye concentration, %	Preheating conditions in water (30 min. at 130° F.)	Peel loss (raw), %	Trim loss (raw), %	Total loss (raw), %
10	none	23	7	30
10	yes	24	5	29
20	none	22	8	30
20	yes	24	6	30

[1] Lye temperature, 210-20° F.; time, 6 minutes; results are averages of three runs, using 135 pounds per run of Unit I Porto Rico sweet potatoes, stored about 90 days at 60° F. 1955-56 season.

TABLE 5
Effect of variety and time in raw storage on peeling and trimming losses [1]

Variety	Days in raw storage at 60° F.	Peel loss (raw), %	Trim loss (raw), %	Total loss (raw), %
Porto Rico	0 days (fresh)	25	8	33
Unit I	10 days (cured)	32	7	39
Unit I	35	28	7	35
Unit I	96	29	6	35
Unit I	152	29	6	35
Goldrush	0 days (fresh)	28	2	30
Goldrush	10 days (cured)	29	2	31
Goldrush	34	34	2	36
Goldrush	97	32	3	35
Goldrush	154	34	3	37
Earlyport	0 days (fresh)	27	4	31
Earlyport	10 days (cured)	25	4	29
Earlyport	41	26	5	31
Earlyport	98	25	3	28
Earlyport	153	29	3	32

[1] Samples, 50 pounds; preheating by immersion in water, 30 minutes at 130° F.; lye concentration, 20%; temperature, 220° F.; time, 6 minutes. 1953-54 season.

losses for the Unit I Porto Rico variety are highest. This would indicate that the Goldrush variety would require less manual work during processing than the Unit I Porto Rico variety and, in some cases, the Earlyport variety. With increasing time in raw storage, losses for the Goldrush variety increased slightly.

SUMMARY

The construction and operation of a pilot scale rotary lye peeler has been described. In using this peeler with sweet potatoes, representative data showed that peeling and trimming losses increased with time in raw storage, particularly at a temperature of 50° F. Losses increased as the size of the potatoes decreased. In comparing Unit I Porto Rico, Goldrush, and Earlyport varieties, it was found that the Goldrush variety had the lowest trimming losses.

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Application of Spore Resistance in the Newer Methods of Process Evaluation[a]

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In addition to species variation, certain other factors, such as conditions under which microorganisms are grown and nature of product in which microorganisms are suspended during test, have long been known to influence resistance to heat. However, there is still a great need for more quantitative data bearing on the resistance of any single species in different menstra.

Recently developed methods *(2, 3, 6)* for evaluating the sterilizing capacity of thermal processes for foods embrace full consideration of relative resistance of microorganisms to heat. Therefore, to apply these methods effectively in the establishment of equivalency among sterilizing processes for different varieties of foods, quantitative data showing the relative resistance of a number of the more important food spoilage species suspended in different food varieties are essential. Owing to the great number of food varieties now sterilized, gathering adequate data of the type needed shall certainly be a major undertaking and much of the work, because of formula variations in specialty items, will have to be done in the laboratories of the food companies concerned.

The few data herein are being reported not as representing completeness in any respect, but rather as demonstrating the type of data needed and how such data may be applied in establishing sterilizing process equivalency. For the sake of simplicity, attention here is confined to processes for destroying highly heat resistant bacterial spores in low-acid food products. However, the same basic principles should apply as well in evaluating processes for destroying low-resistance bacteria, even though the reference base temperature might be different.

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 11, 1956.

THERMAL RESISTANCE DATA NEEDED

Certain equations implementing the newer methods *(6)* of process evaluation contain terms to account for relative resistance of bacteria. These equations follow:

$$U = D(\log a - \log b)$$

$$U = F_c \log^{-1} \frac{250 - RT}{z}$$

$$F_s = D_r(\log a - \log b)$$

$$F_s = F_c + D_r\left(1.084 + \frac{F_x - F_c}{D_r}\right)$$

The following terms account for thermal resistance of spores of the spoilage organism:

D = Time required to kill 90% of spores at some given temperature—as applied here it refers to time at retort temperature.

z = Reciprocal of slope of thermal death time curve.

D_r = Time required at 250° F. to kill 90% of spores.

Any heat processes, according to the above equations, can be equivalent only with respect to the destruction of a specific organism, excepting in rare cases in which the D_r values, and the z values, for two or more organisms are identical. In other words, processes equivalent with respect to destruction of P.A. 3679 spores should not be expected to be equivalent with respect to destruction of *Clostridium botulinum* spores. Therefore, equivalency must necessarily be evaluated in terms of the spoilage organism of primary concern—such an organism might be termed the "reference organism."

The reference organism, P.A. 3679, selected for this study was chosen because of the high heat resistance of its spores compared with the heat resistance of *Cl.*

botulinum spores and because of its widespread use in inoculated pack studies designed to evaluate the adequacy of heat processes for low-acid foods.

Because, for any given spore suspension, thermal resistance values vary in different food products, D_r and z values were determined for P.A. 3679 spores suspended in the food products of concern. With these values and appropriate heat penetration data it was believed possible to establish heat processes for the food products which would be equivalent from the standpoint of reducing any given population of P. A. 3679 spores in the food products.

Devlin *(1)* demonstrated that with carefully determined D_r and z values and appropriate heat penetration data it was possible to predict with remarkable precision the percent spoilage to be expected in an inoculated pack. He inoculated pea puree uniformly with

TABLE 1

Predicted and observed spoilage of pea puree inoculated with 2800 P.A. 3679 spores per 211 x 400 can [1]

Replicate	F_s Value of Process	Predicted spoilage cans/25	Observed spoilage cans/25
1	5.185	19.75	23
2	7.088	2.35	1
3	5.412	16.87	21
4	6.502	5.18	9
5	6.989	2.72	9
6	6.184	7.71	9
7	7.156	2.09	5
8	6.096	8.52	14
Averages		8.15	11.35

[1] Data by Devlin *(1)*.

2800 P.A. 3679 spores per 211 x 400 can and gave the canned puree processes designed to reduce the number of spores per container to the level where only a fraction of the cans of product should spoil from outgrowth of surviving spores. The processes were evaluated and predictions made through application of the newer methods *(6)* of process evaluation. Results of this experiment as reported *(1)* appear in Table 1.

EXPERIMENTAL METHODS

Production and handling of spore suspensions. All procedures involved in media preparation, in spore production, and in estimation of spore concentrations were essentially the same as those described elsewhere *(5)*. A liver broth medium was employed for production of the spores and the thermoresistometer technique *(4)* was used for destroying vegetative cells and activating spores in the spore suspensions in connection with spore enumeration. BBL Eugonagar was employed throughout this study for subculturing heated spores, instead of the pork infusion medium employed in methods referred to above.

Preparation and heating of food samples. For this study pre-canned, pre-sterilized, strained food products were employed —eight different products in all. Further preparation, inoculation, and heating of the food samples were as described elsewhere *(5)*. Each sample of food was inoculated with approximately 10,000 spores and six replicate cups were subjected to time-temperature relationship used. Results of subculture and incubation were evaluated as previously described *(5)*. All subcultures were incubated at 85° F. (29.4° C.) for 3 weeks, an incubation which allowed virtually complete germination of spores that would germinate during a longer period.

RESULTS AND DISCUSSION

Values of z for the spores suspended in the eight different products are given in Table 2. The differences are comparatively small and probably are within the limits of experimental error. It may be concluded therefore that the effects of the different temperatures employed — 230° F. (110° C.), 240° F. (115.6° C.), 250° F. (121.1° C.), 260° F. (126.7° C.), and 270° F.

TABLE 2

Values of z for spores of P. A. 3679 suspended in various food products

Product	z Value
Strained Pork	17.5
Strained Peas	18.0
Strained Vegetables and Beef	17.8
Strained Vegetables and Bacon	17.8
Strained Beets	18.7
Strained Custard Pudding	17.2
Strained Chicken Soup	17.2
Strained Green Beans	17.0

(132.2° C.)—were relatively independent of the nature of the food products. For practical purposes in arriving at sterilizing processes, the average value, 17.6, could be used for calculating processes for all eight products without introducing important errors.

In Table 3 are values of D_r for the spores suspended in the eight different products. Here the differences are marked and must be accounted for in any process calculations if equivalency is to be obtained. The values for the spores in Strained Pork are nearly double those for the spores in Strained Green Beans, and processes designed to accomplish equal reduction of the spores in the two products would have F_s values in direct proportion to the D_r values. This means that, assuming a uniform and equal rate of contamination, a sterilization process would have to be almost twice as severe for Strained Pork as for Strained Green Beans. The other products listed would likewise have to be given processes

TABLE 3

Comparative D_r values for spores of P.A. 3679 suspended in various food products

Product	D_r Values			
	Trial 1	Trial 2	Trial 3	Average
Strained Pork	0.579	0.460	0.456	0.508
Strained Peas	0.468	0.411	0.411	0.430
Strained Vegetables and Beef	—	0.370	0.369	0.370
Strained Vegetables and Bacon	0.410	0.344	0.341	0.365
Strained Beets	0.345	0.323	0.342	0.337
Strained Custard Pudding	0.343	0.317	0.325	0.328
Strained Chicken Soup	—	0.286	0.263	0.274
Strained Green Beans	0.352	0.269	0.243	0.288

in accordance with the D_r values of the spores therein. Should the rate of contamination be appreciably different for the various products, the differences may be accounted for through the following equation which will also account for variations in D_r.

$$F_s = D_r(\log a - \log b)$$

For equivalent processes, b, the number of spores remaining, should be the same for all products. The degree of contamination may be accounted for through a, but if its value is different for the different products the processes arrived at can no longer be considered equivalent except in the amount of spoilage they will allow; they will not be equivalent with respect to reducing the population, percentage-wise, of spores

characterized by D_r values employed in the calculations. From the practical standpoint, equivalency with respect to the amount of spoilage allowed is the primary consideration, but to calculate processes to give such equivalency, appropriate D_r values must be employed.

TABLE 4

Thermal resistance of spores of P.A. 3679, suspended in various food products, expressed as percent of resistance in strained peas

Product	Percent			
	Trial 1	Trial 2	Trial 3	Average
Strained Pork	123.8	112.0	118.3	118.0
Strained Peas	100.0	100.0	100.0	100.0
Strained Vegetables and Beef		90.1	89.9	90.0
Strained Vegetables and Bacon	87.7	83.8	83.0	84.8
Strained Beets	73.8	78.5	83.3	78.5
Strained Custard Pudding	73.4	77.2	79.2	76.6
Strained Chicken Soup		69.6	64.0	66.8
Strained Green Beans	75.2	65.5	59.2	66.7

It may be desirable at times to give a group of products processes more or less severe than would be indicated by D_r values observed for the reference organism, yet still employ processes equivalent with respect to destruction of spores of this organism. This is most easily accomplished by converting the relative D_r values into percent, letting resistance of spores in some given product equal 100%. Table 4 shows the D_r values of Table 3 so converted, resistance in Strained Peas having been given the value 100%. Now any D_r value desired may be assigned to spores in the reference product (Strained Peas in this case) and corresponding values for the other products ascertained by simply multiplying this value by the appropriate factor. These newly calculated values substituted back in the proper equations will permit processes to be calculated which are more or less severe than would have been calculated from observed D_r values but still equivalent with respect to destruction of spores of the reference organism.

Another advantage of this conversion procedure is to equilibrate resistance values which may be obtained for different spore suspensions of the same organism. Different suspensions often show marked differences in resistance (D_r values) even when resistance is determined in the same manner. However, indications are that, relatively, the values vary from product to product in essentially the same order. Further work will be necessary to establish just how reliable this relationship is, i.e., to what extent we may depend on different suspensions being influenced by different substrates in the same manner.

D_r values as given in Table 2 may be used directly in calculations for the prediction of spoilage in inoculated pack work as shown by Devlin *(1)*. Substituting in the equation,

$$F_s = D_r(\log a - \log b),$$

one may determine the F_s of a process which should give the desired reduction in number of spores introduced as inoculum. By methods fully described elsewhere *(6)* the process time and temperature to obtain this desired F_s may be readily calculated. It should be emphasized that D_r and z values must be obtained for the actual spore suspension used in any inoculated pack study. Values as those given in Table 3 are valid only for the one suspension of spores from the standpoint of inoculated pack work. They may be of some value in judging process requirements for similar products, but even here the influence of product variation should not be underemphasized. It will require far more work before reliable generalizations may be made. The data have been reported here solely to emphasize the type of data needed and to demonstrate how such data may be used in process determination.

SUMMARY

Thermal resistance values reported for P.A. 3679 spores suspended in eight different low-acid food products emphasize the influence of product nature upon spore resistance to heat. The value and use of such data in process determination have been explained. The urgent need for more basic data of this type is emphasized.

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The Action of Phosphates in Sausage Products. I. Factors Affecting the Water Retention of Phosphate-Treated Ground Meat[a]

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(Manuscript received June 8, 1956)

THE PRESENT ARTICLE is the third of a series *(16, 17)* concerned with the chemistry and technology of sausage products, such as frankfurters and bologna, and the first of this series concerned with the effects of adding phosphates to meat. The emphasis given this work originated with observations of interest in the industry on possible advantages of adding phosphates to sausage formulas, and recognition of the inadequate knowledge presented by contradictory available reports on the results to be expected from their use.

The practice of adding the phosphates, disodium ortho-, sodium tripoly-, tetra and disodium pyro-, or sodium hexameta-, to pickles for curing pork cuts, such as hams and picnics, has recently become rather common and is accepted by the USDA Meat Inspection Branch *(18)*. This development occurred without the appearance of technical literature on processing and product characteristics; however, its general acceptance is *a priori* evidence that the additives improve one or more of such characteristics as firmness, moisture retention, and color of pork cuts.

Use of phosphate additives in sausage products has not been approved by the Meat Inspection Branch up to the present time. A limited amount of information on effects of phosphate additives in sausage, such as frankfurters and bologna, has been made available. Wilson *(19)* indicated that no beneficial effect was found in tests of several of the phosphates in commercial-type products. On the other hand, Frank *(3)* recently reported that tetrasodium pyrophosphate, but not other phosphates, improved frankfurters with respect to moisture retention. Others who report that phosphate additives can decrease cooking losses and fat separation include Heil *(7)* and Ellerkamp and Hannerland *(2)*. A recently published review by Morse *(13)* of some of the literature on phosphates indicated that there is some agreement, together with considerable speculation, on the properties and function of phosphates in meat. There has as yet been no attempt to report information relating to the effects of phosphates on color, texture, processing time and temperature, and other factors involved in sausage making.

Both laboratory studies and pilot plant investigation have been conducted in the present work to obtain an understanding of the complex relations existing between the properties of meat, curing agents, and processing methods. Results of a comprehensive study of processing and sausage quality that has been carried out in pilot plant work will be described in an additional paper. Background information obtained in the laboratory investigation of the effects of phosphates on meat, especially emphasizing factors affecting water retention, is reported in the present paper. It should be noted that the present paper does not indicate or recommend that increasing the water content of meat products is desirable.

A great deal of foundation information for our work was taken from reports of Grau *et al. (4)* and Möhler and Kiermeier *(8, 9, 10, 11)* and Hamm *(5)*. The results of Grau and of Möhler and Kiermeier *(8)* indicate that increasing the alkalinity of meat increases its ability to retain moisture. According to the latter authors, this explanation only partially accounts for the effects of the polyphosphates *(10)*. As the result of another investigation of the swelling produced by polyphosphates, Bendall *(1)* concluded that increased ionic strength produced the swelling observed in the use of orthophosphates and polyphosphates, except that pyrophosphates produced an additional or "specific" swelling. Bendall proposed that this effect possibly involves splitting actomyosin. The fact that pyrophosphates, under certain conditions, split actomyosin, yielding actin and myosin, has been adequately demonstrated by Straub *(15)*. Tetrasodium pyrophosphate has also been shown by Hasselbach and Schneider *(6)* to be effective in dissolving muscle protein. Its action, according to Mommaerts *(12)*, is markedly sensitive to temperature and the presence of magnesium. As will be discussed, some of the experiments described herein were designed to investigate the "specific" effect stressed by Bendall, since this effect would possibly be of importance. In a recently-published paper, Hamm *(5)* attributed phosphate effects partly to increasing meat pH and to salting action, and also, the importance of the binding of calcium and magnesium was stressed as an important factor affecting the action of the phosphates on meats.

Inasmuch as previous studies on water retention have not yielded consistent and conclusive evidence as to the relative importance of ionic strength, pH, time, and temperature, and of the importance of a "specific" effect and of calcium and magnesium binding, this investigation centered around the study of these factors. The additives studied were mainly mixtures of sodium chloride and pyrophosphates and, to a limited extent, mixtures of sodium chloride with the sodium orthophosphates. In the investigations of the mechanism of additives, calcium and magnesium chlorides and potassium iodide were added.

METHODS

The principal method employed in determining moisture retention was a modification of that described by Bendall *(1)*. This involved adding solutions of salts to meat in the propor-

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 12, 1956.

tion of 2 ml. of solution to 1 g. of meat and measuring unabsorbed solution after samples had been stored and centrifuged (Method A-C) and again after they had been heated (Method A-H). A smaller number of experiments was conducted using a method which involved determining the amount of moisture evaporated on heating meat treated with salt solutions in the proportion of 0.5 ml. of solution per gram of meat. Several exceptions are noted in the descriptions of the experiments; otherwise, the methods used are described in the following:

Method A-C: Sufficient frozen beef for an entire experiment was completely thawed, trimmed as free as possible of fat and connective tissue, ground through an ordinary food chopper, and thoroughly mixed. Twenty-g. (± .02 g.) portions of meat were placed in 60 ml.-capacity centrifuge tubes and 20 ml. of salt solution at *ca.* 32-41° F. (0.5° C.) was added to each tube by pipette. The solutions and the meat were thoroughly mixed with a stirring rod, after which the mixtures were allowed to stand for approximately 16 hours at 32° F. (0° C.) The tubes were then centrifuged for 15 minutes at 3300 r.p.m. in a Servall angle centrifuge. The volume of supernatant liquid which separated in each tube was determined by decanting the fluid into a 25 ml. graduated cylinder calibrated at 0.2 ml. intervals. The volume of the samples of the treated meat was calculated by subtracting the volume of the decanted supernatant liquid from the original total volume, assumed to be 40 ml. These averages of values, obtained in duplicate determinations, expressed as a percentage of the original volume of the meat which was assumed to be 20 ml. for this purpose, are termed "unheated" volumes.

Method A-H: The centrifuge tubes containing the swollen meat were placed in a water bath at 158° F. (70° C.) for 15 minutes. Any supernatant liquid released from the meat was immediately decanted and its volume measured as described above. The volume of the samples of heated meat was calculated by determining the sum of the volume of solution released on heating and the volume of solution decanted in following Method A-C, and subtracting this sum from 40 ml. The average of volumes of duplicate determinations was also expressed as percentages of the original volume of the meat (20 ml.) and termed the "heated" volume.

Fifteen samples from a single batch of ground beef treated with 1% $Na_4P_2O_7/Na_2H_2P_2O_7$-1.7% NaCl, pH 7.5, had a mean unheated volume of 150.1%, mean deviation, ± 1.18%, and a mean heated volume of 112.4%, mean deviation ± 2.06%.

Method B: A thoroughly mixed 300-g. batch of ground beef was divided into two 150-g. portions; 75 ml. of different solutions were added to the 150-g. portions at 32-41° F. (0-5° C.); the solutions and meat were thoroughly mixed; and the mixtures allowed to stand overnight at 32-41° F. (0-5° C.). After storage, the mixtures were again thoroughly stirred and six 30-g. (± .01 g.) portions of each batch were transferred to tared aluminum dishes. The dishes and contents were weighed and placed in a constant temperature oven equipped with a revolving shelf, at 167° F. (75° C.). After two hours of heating, the dishes and contents were removed, cooled one-half hour to room temperature, and weighed. From the data obtained, the moisture lost by evaporation was calculated; these losses are expressed in the following as percentages of the weight of the original samples (30 g.). The mean evaporation of samples representing each treatment was calculated and the significance of any differences between the two means was determined using the "t" test.

Preparation of solutions. The pyro- and orthophosphate solutions employed were titrated to adjust them with respect to pH value and, frequently, were also adjusted with respect to ionic strength. Freshly prepared solutions were always used. The concentrations of solutions of $Na_4P_2O_7/Na_2H_2P_2O_7$ and Na_2HPO_4/NaH_2PO_4 are expressed as the concentrations of the $Na_2H_2P_2O_7$ and NaH_2PO_4, respectively, that would be available on complete acidification.

Meat used. The meat used, except for rabbit meat employed in one series of experiments, was steer beef. The meat was separated from carcasses stored at 37° F. (2.8° C.) for 3-7 days after slaughter. The meat was wrapped in cellophane and placed in boxes holding either 25 or 50 pounds of meat. These were stored at 0° F. (—17.8° C.). Portions were cut from the blocks of beef with a bandsaw as needed and allowed to thaw overnight. Muscle sections which were relatively free of fat or connective tissue were removed for experimental use. The various storage periods during which the beef was frozen are indicated in the descriptions of experiments that follow.

EXPERIMENTAL AND RESULTS

Relation of unheated to heated volumes. Relation of unheated to heated volumes was investigated, using Methods A-C and A-H, respectively, on steer beef which had been frozen approximately 7 weeks. The treatments applied consisted of different solutions containing from 3.6 to 8.0% sodium chloride and different solutions of 1% $Na_4P_2O_7/Na_2H_2P_2O_7$-1.7% NaCl, varying with respect to pH over the range 5.5 to 9.0. Under these conditions, increasing pH was accompanied by increasing ionic strength. The results of this experiment, represented by curves showing the relation between unheated and heated volumes, are shown in Figure 1.

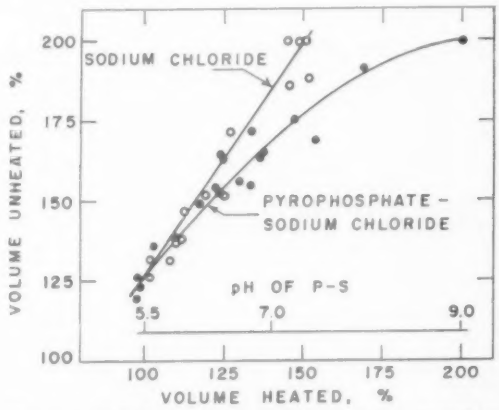

Figure 1. Relation of volumes of unheated to heated meat samples treated with sodium chloride (○) and pyrophosphate-sodium chloride, pH 5.5 to 9.0 (●).

The unheated and heated volumes of samples treated with sodium chloride solutions were found to be linearly related. Part of the curve expressing the relation of the unheated and heated volumes of samples treated with pyrophosphate-sodium chloride solutions of pH 7, or less, closely approached this straight line. On the other hand, the overall relation of heated and unheated volumes of samples treated with pyrophosphate-sodium chloride solutions was curvilinear, *i.e.*, as the alkalinity (and ionic strength) of the solutions applied to the meat increased, the tendency to retain moisture on heating increased. This result indicates that errors may be introduced by determining the relative merits of treatment with solutions of high pH on the basis of unheated volumes only, although for many purposes this determination alone is sufficient. It was noted in repetitions of the above experiment that, possibly owing to differences in beef, curves shown in Figure 1 were not exactly reproduced, although the slope was the same. From his investigation of this relationship, Bendall *(1)* reported that volumes of unheated and heated samples were linearly related for all of the more limited range of treatments studied.

Effect of varying temperature of storage. Three series, each consisting of 6 samples, were prepared, the samples in a series being treated either with (1) 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.5; (2) 1.42% Na_2HPO_4/NaH_2PO_4–1.7% NaCl, pH 7.0; or (3) 3.4% NaCl. Steer beef which had been frozen one week was used. Methods A-C and A-H were followed, except that pairs of samples from each series were stored at 32° F. (0° C.), 50° F. (10° C.), or 68° F. (20° C.). The volumes of the samples after storage at the 3 temperatures are shown in Figure 2. Results show that the volume of samples treated with pyrophosphate-sodium chloride and orthophosphate-sodium chloride markedly decrease as the temperature of storage increased. Varying the temperature had no similar effect on the volume of samples treated only with sodium chloride. It is not possible at present to propose a reliable explanation for the observed difference. These results indicate that maintaining temperatures approaching 32° F. (0° C.) may be of considerable practical importance in obtaining optimum moisture retention in using phosphates.

Effect of varying time of storage. Two series of samples were prepared; the samples in one series were treated with a solution of 1.0% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 6.8, and those in the other with a solution of 3.6% NaCl. Using steer beef which had been frozen 3 weeks, Method A-C was followed except that the samples were stored at 32° F. (0° C.) for different intervals ranging from 1 to 30 hours. Curves based on

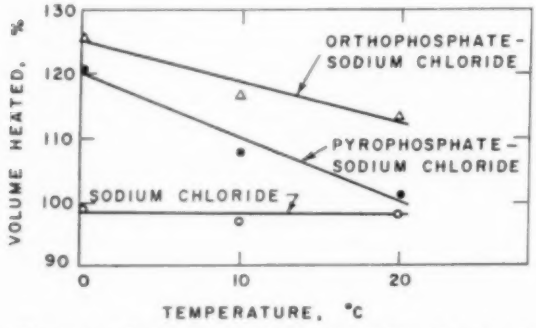

Figure 2. Effect on volumes of meat samples of treatments at different temperatures with orthophosphate-sodium chloride (△), pyrophosphate-sodium chloride (●) and sodium chloride (○).

the results, showing the relation between volumes and time in storage, and also between volumes, expressed as a percentage of the maximum attained (in 30 hours), and time in storage, are shown in Figure 3.

The slopes of the curves indicate that the volume of the samples in both series increased with increasing storage; after 16 hours of storage the volumes were only slightly less than those obtained after 30 hours of storage. Curves showing the relation between the volumes, expressed as percentage of maximum volume, and time of storage were similar, indicating that there was no fundamental difference in the rate at which the two treatments attained maximum effectiveness.

In another experiment it was found that treating meat that had been more thoroughly minced by grinding it through a $\frac{1}{16}$-inch plate required approximately the same amount of time to become fully effective. The importance of the time factor has previously been observed in extracting muscle proteins; for example, 20-minute extractions separate myosin from actomyosin, although the same solution extracts actomyosin over a longer period of time *(6)*. The evidence showed that allowing sufficient time for the reaction(s), probably not in excess of 16 hours, is essential in obtaining a major portion of the potential moisture retention.

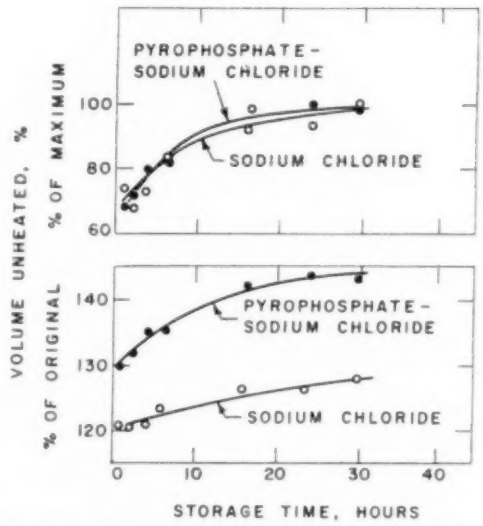

Figure 3. Effect of varying storage at 0° C. on volumes of meat samples treated with pyrophosphate-sodium chloride (●) and with sodium chloride (○).

The effects of pH and ionic strength.[b] Two series of samples were prepared; one series of samples was treated with solutions of 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl adjusted to pH values of 5.3, 5.5, 5.75, 6.0, 6.45, and 7.0, having ionic strength values of 0.305, 0.307, 0.312, 0.320, 0.331, and 0.349, respectively. The other series of samples was treated with 3.574, 3.613, 3.655, 3.755, 3.884, and 4.094% solutions of NaCl, the ionic strength values of these solutions corresponding with those of the solutions of pyrophosphate-sodium chloride. Using steer beef which had been frozen for one week, all samples were treated by Method A-C. The relation of the volumes (unheated) of samples to the ionic strength of the solutions applied is indicated by the curves shown in Figure 4. A curve is included which shows the volume of the samples treated with pyrophosphate-sodium chloride in relation to ionic strengths (μ) corrected for the buffering action of the meat. To calculate the latter values, it was assumed that the ionic strength values were the sum of the ionic strength of sodium chloride (1) directly added and (2) that formed during the titration to adjust the pH of the solutions, and the ionic strength of $Na_4P_2O_7/Na_2H_2P_2O_7$ at the pH (5.45 to 5.95) of the treated samples. Reduction of the pH of solutions in the

[b] The concentration of each ion (in gram-ions per 1000 g. solvent) is multiplied by the square of its valence; the sum of these quantities, divided by 2, equals ionic strength.

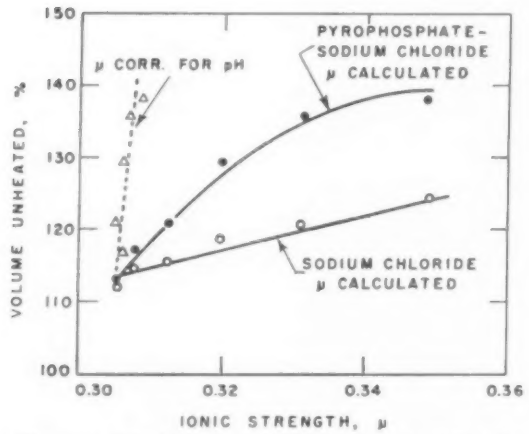

Figure 4. Effect of varying pH and ionic strength (μ) on volumes of meat samples treated with pyrophosphate-sodium chloride (●) and with sodium chloride (○) shown in relation to μ directly calculated. Also the volume of pyrophosphate-sodium chloride treated samples are shown with reference to μ corrected for the buffering action of the meat. (△).

presence of the meat sharply reduced ionic strength, since the ratio of the ionic strength of $Na_4P_2O_7$ to that of $Na_2H_2P_2O_7$ is 10 to 3. Similar calculations were made in the work reported by Bendall *(1)*.

Moisture retention of meat treated with sodium chloride was linearly related to the ionic strength of the solutions applied. The volumes of meat treated with pyrophosphate-sodium chloride solutions exceeded that of meat treated only with sodium chloride at any corresponding ionic strength; furthermore, the differences increased with increasing ionic strength and pH. The greater effect of the pyrophosphate-sodium chloride treatments appears to be attributable to the effect of the alkalinity of the pyrophosphate solutions. If the special calculations of ionic strength values described above are assumed to be valid, the effects of increasing pH appear even more pronounced, since the curve indicating the relation of volumes to ionic strength values modified by the meat shows that the volumes of pyrophosphate-sodium chloride treated samples increased markedly at nearly constant ionic strength (0.305 to 0.309). Other factors possibly involved in the effect of the pyrophosphates, such as binding of calcium and magnesium and a specific effect, do not appear to be of major importance, based on further observations discussed in the following.

Specificity. In a second experiment, solutions consisting of 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.5, 0.66 ionic strength, and 1.68% Na_2HPO_4/NaH_2PO_4-1.7% NaCl, pH 7.0, 0.66 ionic strength, were used to treat samples of muscle from freshly killed rabbits, treatments being applied after storage at 37° F. (2.8° C. for 2, 22, 24, 46, and 140 hours post mortem. Methods A-C and A-H were followed. The results, showing the heated volumes and the pH of treated samples, are given in Table 1.

Slightly larger volumes were obtained in treating fresh (stored 2 hours) muscle with pyrophosphate-sodium chloride than with orthophosphate-sodium chloride. On the other hand, the volume of muscles stored 22 or more hours was increased somewhat more by the treatment with orthophosphate-sodium chloride. One explanation of this is that the orthophosphate was more effective in buffering against the decrease in pH as the meat aged. The data show that the orthophosphate-sodium chloride treatment increased the pH of muscle stored 22 or more hours as much as 0.2 units more than did the pyrophosphate-sodium chloride treatment. The fact that the treatments with pyrophosphate-sodium chloride solutions were less effective than those with orthophosphate-sodium chloride, when applied to stored samples presumably containing considerable actomyosin, appears to indicate that the mode of action of the pyrophosphate did not involve any appreciable specific action, such as splitting actomyosin as Bendall *(1)* proposed. Otherwise, it would have exerted an equal or probably greater effect as compared with orthophosphate, which has not been reported to exert a splitting or specific action on actomyosin, except insofar as salts in general may possess some activity. Their buffering action, along with their effect in increasing ionic strength, appear to be principal factors determining the order of effectiveness of the pyro- and orthophosphate-sodium chloride combinations.

Marked effect achieved with potassium iodide. Employing Methods A-C and A-H, using steer beef which had been frozen for 20 weeks, a series of samples was treated with solutions containing 3.63% NaCl; 3.59% NaCl-0.10% KI; 3.26% NaCl-1.03% KI; 2.7% NaCl-2.57% KI; and 1.82% NaCl-5.15% KI, the ionic strength of all solutions being 0.62. The effect of varying the proportions of the salts on moisture retention, as indicated by the volume of heated samples after treatment with the various combinations, is shown in Figure 5. The results show that the addition of potassium iodide markedly increased the retention of moisture, the effect increasing as the concentration of KI increased.

TABLE 1
Volume and pH of fresh and stored rabbit muscle treated with pyro- and orthophosphates and sodium chloride

Rabbit number		1	2		3		4	
Storage, hours		2	22	46	2	24	2	140
Treatment								
Pyrophosphate-sodium chloride[1]	volume, %	146	122	153	130	113	134	120
	pH	6.55	6.60	6.70	6.45	6.60	6.60	6.30
Orthophosphate-sodium chloride[2]	volume, %	140	147	165	121	122	126	122
	pH	6.55	6.80	6.75	6.50	6.70	6.65	6.50

[1] 1% $Na_4P_2O_7/Na_2H_2P_2O_7$-1.7% NaCl, pH 7.5, ionic strength, 0.66.
[2] 1.42% Na_2HPO_4/NaH_2PO_4-1.7% NaCl, pH 7.0, ionic strength, 0.66.

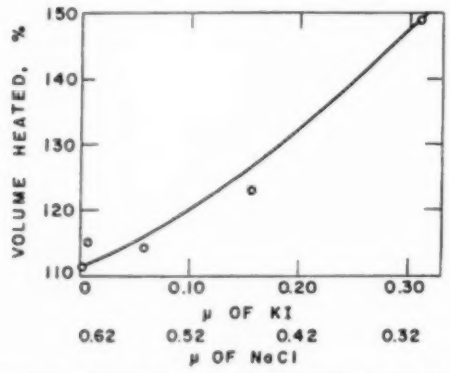

Figure 5. Volumes of meat samples treated with different proportions of NaCl and KI at constant ionic strength (μ) of 0.62.

In further investigating the effect of potassium iodide using Methods A-C and A-H, it was found that samples treated with solutions at pH 7.5 and ionic strength 0.67 and consisting of 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl; 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.69% NaCl and 0.017% KI; 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.64% NaCl and 0.17% KI; and 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.11% NaCl and 1.66% KI, had heated volumes of 129, 126, 127, and 167%, respectively. These results showed that treatment with solutions containing 1.66% KI markedly enhanced the retention of moisture as compared with pyrophosphate-sodium chloride while smaller amounts had no discernible effect. The contribution of potassium iodide to the total ionic strength, 0.67, of the solution was only 0.1 in this case. Similar results were obtained with NaI. The results point to the conclusion that the iodides produced an effect that the other additives produce only mildly, if at all, and thus was "specific." The addition of iodides produced no measurable effect on the pH of the meat; consequently, its effect could not be explained on the basis of its affecting either pH or ionic strength. KI has previously been found to increase the efficiency of muscle extraction, possessing, it is thought, a depolymerizing action on actin polymer and a dissociating action on actomyosin *(14)*. While iodides have no practical use in sausage formulations, their pronounced effects indicate the possibilities which exist if their mechanism of action can be duplicated with a chemical acceptable in food.

Effect of adding calcium and magnesium chlorides with other additives. In a series of experiments samples were treated with 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.5, and other samples with this solution plus 0.095% $MgCl_2$ or 0.11%, $CaCl_2$. Using steer beef which had been frozen for 4 weeks, the samples were treated by Methods A-C and A-H with the results shown in Table 2. It was found that the addition of $CaCl_2$, reduced and $MgCl_2$ increased meat volumes, the effects being consistent but not large. The results of Experiment 1, of Table 2, which was undertaken to obtain a statistical appraisal of these small differences, showed the increased volume obtained on adding $MgCl_2$ to be significant. In other experiments, the details of which are not reported, the two alkaline earth salts increased the moisture retention of samples treated with solutions of either sodium chloride or orthophosphate-sodium chloride to a similar extent.

The present results contrast, in part, with observations of previous workers. Bendall reported that the addition of 0.05M solutions of $MgCl_2$ had no effect on moisture retention, although he assumed that addition of the salt should improve the retention of moisture *(1)*. Hamm proposed that binding of calcium and magnesium are important functions of the phosphates in increasing the moisture retention of meat *(5)*. This appears inconsistent with the present results insofar as the effect of magnesium is concerned. Recognition of the number of known effects Mg has on muscle components and reactions of these components *(14)* precludes any present attempt to explain the beneficial effect of adding $MgCl_2$. Although the observed effects were not large, it tentatively appears that its addition to meat may have some practical value.

Experiments relating effectiveness to solubilization of proteins. The effect of treatments with pyrophosphate-sodium chloride solutions of different ionic strength and pH on meat volumes and, especially, on the solubility of proteins was investigated. Samples were treated with solutions of 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, adjusted to pH values of 6.0, 7.25, and 8.5. The volumes (unheated) of the samples and the total and (acto)myosin nitrogen content of the solutions separated by centrifugation in following Method A-C were determined with the result shown in Table 3. The steer beef used had been frozen for 20 weeks. The nitrogen content of the precipitate formed on dilution of the supernatant liquid with 10 parts of water was considered to be (acto)myosin nitrogen.

Results show that volume of meat, concentration of nitrogen found in the supernatant liquid, and proportion of the dissolved nitrogen estimated to be (acto) myosin nitrogen increased as the pH and ionic strength of the applied solutions increased.

To evaluate the effect on meat volumes of heating

TABLE 2

Effect of adding $CaCl_2$ and $MgCl_2$ on volume of pyrophosphate-sodium chloride treated meat

Treatment	Volume, heated, %							
	Experiment 1		Experiment 2		Experiment 3		Experiment 4	
1—1% $Na_4P_2O_7/Na_2H_2P_2O_7$-1.7% NaCl, pH 7.5	103[1]	(140)[2]	103	(6.50)[3]	108	(6.60)	129	(6.40)
2—0.095% $MgCl_2$ added to 1	106	(142)	110	(6.50)	113	(6.60)	134	(6.35)
3—0.165% $CaCl_2$ added to 1			100	(6.40)	100	(6.50)	121	(6.40)

[1] Mean of six determinations, difference between 103 and 106% significant at the 10% level.
[2] Unheated volumes, means of six determinations, difference between 140 and 142% significant at the 5% level.
[3] pH values.

TABLE 3

Meat volume and solubility of proteins at varying pH and ionic strength

Treatment	Solution[1] pH	Volume unheated[2]	Nitrogen content of supernatant liquid	
			per ml.	(acto) myosin N_2
		%	*mg.*	%
1	6.0	128	5.88	18.9
2	7.25	149	6.35	37.6
3	8.5	179	7.41	39.8

[1] 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl.
[2] % of original volume (20 ml.) of beef.

dissolved proteins, the effect of heating samples treated with pyrophosphate-sodium chloride solutions before, rather than after, centrifugation was determined. Solutions of 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl at pH values 5.6, 7.0, and 8.5 and ionic strength values 0.57, 0.66, and 0.73, respectively, were used. The meat used had been frozen for 24 weeks. Two procedures were applied: (1) Methods A-C and A-H, and (2) a modification of these in which samples were heated 15 minutes at 167° F. (75° C.) and then centrifuged 15 minutes, the usual order of these operations being reversed. Through comparison of the volumes (heated) obtained in following the two procedures, the effect of heating the solutions of proteins in contact with the meat mass was determined. The data obtained using the two methods are given in Table 4.

TABLE 4

Comparison of the effect on meat volume of heating meat-solution-mixtures before and after centrifuging

Treatment	Solution[1]		Volume of meat	
	pH	Ionic strength	Method A-H	Modified method[2]
			%	%
1	5.6	.57	100	
2	5.6	.57		123
3	7.0	.66	122	
4	7.0	.66		141
5	8.5	.73	153	
6	8.5	.73		178

[1] 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl.
[2] Centrifugation, as in Method A-C, omitted; samples heated 15 minutes at 167° F. (75° C.) and centrifuged.

Results show that the volumes of samples which had been heated with all of the solutions containing dissolved proteins in contact with the meat were appreciably larger than the volumes of samples treated by Methods A-C and A-H, which were heated with only that solution intermixed with the meat which could not be separated by centrifugation in following Method A-C. From calculations based on the nitrogen content of the supernatant liquids (Table 3) and the data in Table 4, it was estimated that 1 g. of dissolved protein was responsible for retaining approximately 10 g. of moisture when heated in the presence of the meat mass.

Evaporation of moisture from treated samples heated 2 hours at 167° F. (75° C.). Inasmuch as the ordinary procedure in sausage making involves heating comminuted meat treated with no excess moisture and generally involves evaporation losses rather than separation of liquid fractions, Method B was applied to simulate practice in comparing the effect of treatments. A series of experiments was performed which afforded comparison of the evaporation of pairs of treatments, each experiment involving a comparison of the mean evaporation from 6 samples representing each of the two treatments. The solutions used, grouped in the pairs compared in individual experiments, were (1) no additive vs. 5% NaCl, (2) 5% NaCl vs. 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 8.5, (3) 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.0, vs. pH 8.5, (4) 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.5 vs. 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.11% NaCl–1.66% KI, pH 7.5, and (5) 1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.5 vs. 1.42% Na_2HPO_4/NaH_2PO_4–1.87% NaCl, pH 7.5. The steer beef used had been frozen for 24-26 weeks. Significance of differences between means was determined with the "t" test. The results of the experiments are shown in Table 5. As indicated by the results, the order of effectiveness of treatments was that previously obtained by Methods A-C and A-H, *i.e.* orthophosphate-sodium chloride being more effective than pyrophosphate-sodium chloride at the same pH and ionic strength, the addition of KI increasing the effectiveness of pyrophosphate-sodium chloride, the pyrophosphates being more effective at higher pH, and pyrophosphates-sodium chloride being more effective than sodium chloride alone. The differences representing losses through evaporation were rather small. Since the exposed surface area of meat in the aluminum dishes had approximately the same relationship to the weight of

TABLE 5

Comparison of evaporation of moisture from samples held 2 hours at 167° F. (75° C.)

Number	Treatment	Differential evaporation		
		Evaporation[1]	Difference	Difference for 1% level
		%	%	%
1	Water	9.06		
	5% NaCl	8.30	0.76	0.73
	Water	9.50		
	5% NaCl	8.46	1.04	0.41
2	5% NaCl	8.95		
	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 8.5	8.23	0.72	0.53
	5% NaCl	8.85		
	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 8.5	8.41	0.44	0.35
	5% NaCl	9.63		
	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 8.5	8.71	0.92	0.55
3	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.0	9.22		
	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 8.5	8.66	0.56	0.50
	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.0	10.23		
	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 8.5	9.63	0.60	0.53
4	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.5[2]	9.86		
	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.11% NaCl —1.66% KI, pH 7.5	9.11	0.75	0.35
5	1% $Na_4P_2O_7/Na_2H_2P_2O_7$–1.7% NaCl, pH 7.5[2]	10.69		
	1.42% Na_2HPO_4/NaH_2PO_4–1.87% NaCl, pH 7.5	9.70	0.99	0.43

[1] Mean evaporation of six samples.
[2] Ionic strength (μ) of each solution of pair was 0.67.

these samples as the surface of typical bologna has to its weight, it appears that only excellently controlled tests would prove that phosphate treatment reduced smokehouse losses in actual sausage-making operations.

SUMMARY

The moisture retention of lean meat treated with sodium chloride, pyrophosphate-sodium chloride, and other additives was investigated by a method involving the addition of solutions of salts in excess and measuring the amount of this excess after the samples were stored and centrifuged, and again after they were heated.

It was shown that unheated volumes were linearly related to heated volumes when samples were treated with sodium chloride, and curvilinearly related when samples were treated with pyrophosphate-sodium chloride.

It was found that the effectiveness of treatments with pyro- or orthophosphate-sodium chloride decreased as the temperature of application increased from 32 to 68° F. (0 to 20° C.). The effectiveness of treatments with sodium chloride was not similarly affected. These results emphasized the importance of maintaining low temperatures (*ca.* 32-41° F. or 0-5° C.) in using phosphate additives to obtain optimum moisture retention.

The rate at which sodium chloride and pyrophosphate-sodium chloride react with meat to produce their maximum effect was shown to be the same. The results showed that a nearly optimum effect was obtained after storage for 16 hours at 32° F. (0° C.).

Results show that the effectiveness of treatments with pyrophosphates was primarily related to the ionic strength and pH of the solutions applied. Aside from the pH of solutions, their capacity in buffering was shown to be important. Evidence failed to support a hypothesis that pyrophosphates exert an effect basically different from, or superior to, that of orthophosphates, at least under the conditions of these tests.

Addition of KI and NaI markedly enhanced moisture retention by exerting an effect different from, or markedly greater than, that of other additives and was thus "specific." Duplication of this mechanism with an acceptable food additive is a challenge.

Results showed that treatments with pyrophosphates dissolve proteins, especially (acto)myosin, to an extent affected by ionic strength and pH. Heating the dissolved protein in the presence of the meat markedly enhanced retention of moisture by the meat. Some of the factors influencing the effectiveness of various treatments were also found to affect the evaporation of moisture from samples heated at 167° F. (75° C.).

The findings are, in general, consistent with the premise that the factors governing the moisture retention of meat treated with phosphate additives are those which influence solubilization of muscle proteins; namely, temperature, time, ionic strength, and pH of treatments; and that specific effects can be exerted by ions, such as the I- and Mg^{++} ions.

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Growth Characteristics of Spoilage Organisms in Orange Juice And Concentrate[a]

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IT HAS BEEN WELL ESTABLISHED that outbreaks of spoilage in orange concentrate, manifested by "buttermilk" off-flavors and odors, may be caused by the growth of bacteria belonging to the genera *Lactobacillus* and *Leuconostoc (4, 5, 6, 7)*. Murdock and DuBois *(11)* studied the effect of temperature and degree Brix on growth characteristics of *Leuconostoc* and *Lactobacillus* strains and osmophilic yeasts at 75° F. They noted that the bacteria grew in all concentrations through 30° Brix, and the yeasts in concentrations through 58.5° Brix. These workers further studied the survival of the same organisms at temperatures of 40° F. and below.

Information on growth rates of lactic acid bacteria in orange juice and concentrate is sparse. Rushing, Veldhuis and Senn *(13)* found that growth rates increased with a rise in pH, and decreased with an increase in degree Brix. These workers showed that at 69.8° F. (21° C.) both *Lactobacillus plantarum* var. *mobilis* and *Leuconostoc dextranicum* grew in 18° Brix concentrate at pH 3.4 and in 42° Brix concentrate at pH 3.80, and that for a strain of *Leuconostoc mesenteroides*, no growth occurred below pH 3.8, nor above 37° Brix. They also found that a generation time of 1.4 hours for *L. mesenteroides* in 12° Brix at pH 4.0 was the shortest measured for all the organisms tested.

The ability of orange juice concentrate packers to evaluate properly their potential spoilage problems is dependent upon accurate technical information concerning the growth rates of spoilage organisms in the various unit operations. The purpose of this study was, first, to determine the effect of concentration and temperature on the growth characteristics of selected test organisms in orange juice and concentrates and, second, to determine what precautions—based upon these growth characteristics—may be indicated to minimize the production of off-flavors by the growth of these organisms.

EXPERIMENTAL METHODS

The juice and concentrate used in this study were prepared from 58° Brix Valencia orange concentrate furnished by the Minute Maid Corporation, Plymouth, Florida. It had a Brix/acid ratio of 16.7 and a pH value of 3.85.

The 58° Brix concentrate was diluted with distilled water to the desired final concentration using a Zeiss Opton hand sugar refractometer. Then 150 ml. portions were filled into 8-ounce screw cap bottles and sterilized in flowing steam for 10 minutes. The pH values after sterilization were 3.90 for the 12° and 20° Brix concentrates, and 3.80 for the 30°, 42° and 58° Brix concentrates.

Test organisms used in the study included: *Leuconostoc sp.* (C. C. C. No. LE 3) obtained from Dr. R. H. Vaughn, University of California, Davis, California, March, 1954; *Lactobacillus plantarum* var. *mobilis* (C. C. C. No. LA 6) obtained from the American Can Company, November, 1952; and *Zygosaccharomyces vini* (C. C. C. No. Y 35) osmophilic yeast obtained from Mr. D. I. Murdock, Minute Maid Corporation.

Physiologically young (log phase) cultures growing at 86° F. in juice or concentrate were used to inoculate an 8-ounce test sample bottle. Inoculum was grown in juice having the same degree Brix and temperature as each sample bottle under test. Each culture was direct counted microscopically using a Petroff-Hausser chamber and dark phase contrast and appropriately diluted so that each test bottle contained approximately 10,000 organisms per ml. This procedure was designed to keep the inoculating procedure constant and to reduce the lag times to a minimum insofar as practical. After the freshly prepared samples which had been previously adjusted to the desired temperature were inoculated, they were incubated statically, and viable numbers of organisms were determined at specific time intervals by plating 1 ml. aliquots in duplicate using orange serum agar (Exchange Orange Products Company). Plates were counted after 2-3 days incubation at 86° F.

All variables were first tested at 86° F., followed by 50°, 40°, and 60° F. in that order. With this procedure, certain variables were eliminated as being unnecessary on the basis of the data as it accumulated.

Growth curves were constructed with the log base 10 of the number of viable organisms as the ordinate and time as the abscissa. The exponential phase of growth (straight line) was drawn by using the Method of Averages *(3)*. In this study, growth rate was determined from the cell concentration which is equivalent to division rate, and not cell density which may be a function of changing cell size from one growth phase to another.

Lag times were measured according to the method of Lodge and Hinshelwood *(9)* as discussed by Monod *(10)*.

Generation times were calculated from the expression:

$$G = \frac{0.3\ (t_1 - t)}{\text{Log } N_1 - \text{Log } N}$$

where G = Generation time in hours
N_1 = Number of organisms at time t_1
N = Number of organisms at time t

RESULTS AND DISCUSSION

Growth and survival curves prepared from viable count data are shown in Figures 1 through 5. Generation times are presented in Table 1.

Optimum test conditions for the growth of all 3 organisms were concentrations of 12° to 20° Brix at 86° F. In 12° Brix the *Leuconostoc* had a generation time of 1.3 hours and reached a total cell concentration of approximately 1 billion cells per ml. in one day from an initial count of 10,000 per ml. At 12° Brix, the *Lactobacillus* strain showed a generation time of 1.6 hours and also developed a maximum concentration of about 1 billion cells per ml. in one day. The yeast showed generation times of 2.6 and 2.7 hours in 12° and 20° Brix, respectively, and reached a final cell concentration of about 50 million per ml. in 2 days' time.

Growth rates for the 3 test organisms became progressively slower as the temperature decreased from 86° F., and also as the Brix increased from the 12 to 20° level.

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, June 13, 1956.

[b] Present address Dept. of Food Technology, University of Illinois, Urbana, Illinois.

TABLE 1
Effect of temperature and Brix on generation times (in hours)

Temperature F.	*Leuconostoc sp.*					*Lactobacillus plantarum* var. *mobilis*					*Zygosaccharomyces vini*				
	Degree Brix					Degree Brix					Degree Brix				
	12	20	30	42	58	12	20	30	42	58	12	20	30	42	58
86	1.3	1.3	2.3	—	—	1.6	2.0	3.3	—	—	2.7	2.6	3.2	4.0	9.2
60	3.8	4.5	7.8	—	—	10.6	12.0	26.6	—	—	7.4	7.5	8.8	13.0	31.2
50	9.6	14.9	—	—	—	55.0	60.0	—	—	—	18.6	21.5	22.0	39.5	—
40	—	—	—	—	—	—	—	—	—	—	103.0	88.0	84.0	96.0	—
						(— No Growth)									

Minimum temperature and the maximum degree Brix permitting growth were interrelated; that is, the *Leuconostoc* and *Lactobacillus* grew in 30° Brix at 60° F., but not 50° F.; the yeast grew in 58° Brix at 60° F. but not at 50° F.

Both the *Leuconostoc* and *Lactobacillus* strains died in 42° Brix and above regardless of temperature, and both died at 40° F. regardless of degree Brix. At 40° F., the yeast grew slowly in all concentrations through 42° Brix.

Data presented in Table 2 show that 16 out of 34 growth curves had no measurable lag phases. From a knowledge of the condition of an inoculum and its relation to the environment into which it was subcultured, the presence or absence of lag phases in the growth curves can be fairly well predicted. For instance, since all cultures used for inoculating test variables were grown at 86° F., it is not surprising that lag times increased as the incubation temperature of the test variable decreased from 86° F. to 40° F. Lag phases also generally occurred when a cell concentration of the inoculum exceeded several hundred million per ml., indicating that the culture was probably in the retardation phase, and when the inoculum was subcultured from one concentrate to another. With but ont exception,

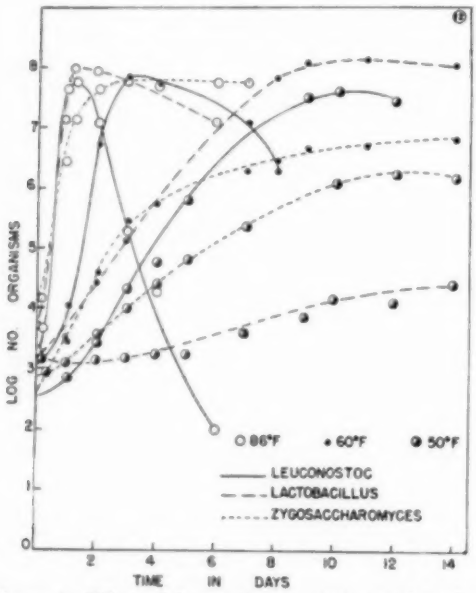

Figure 1. Effect of temperature on test organisms in 12° Brix orange juice.

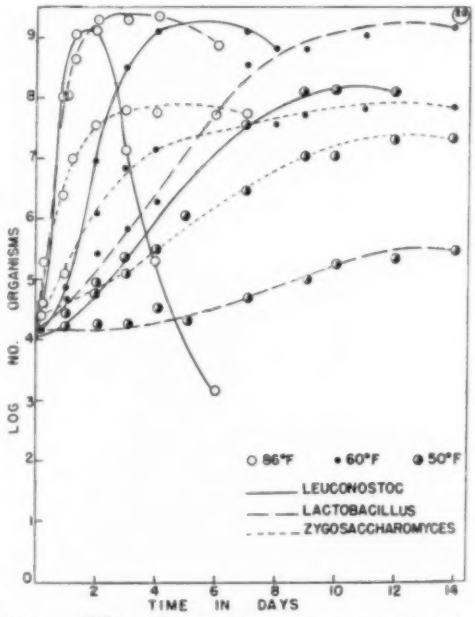

Figure 2. Effect of temperature on test organisms in 20° Brix orange juice concentrate.

lag phases were induced in cultures of *Leuconostoc* and *Lactobacillus* strains under these conditions. Thus, as was to be expected, lags were independent of growth conditions, and were functions only of the nature of the inoculating culture. Most of the growth curves obtained by Murdock and DuBois *(11)* showed long lag phases. This was to be expected from the technique used in preparing the suspensions where cultures were grown on slants, washed off with distilled water, and then stored in the refrigerator prior to use.

Under conditions of high Brix and low temperature, minor anomolies occurred in the growth curve characteristics. The *Leuconostoc* in 30° Brix at 50° F. exhibited approximately a 90% reduction in viable numbers in 2 days, after which the counts increased until they reached the level of concentration originally present. The yeast in 42° Brix at 40° F. showed a somewhat similar phenomenon; after a 90% reduction at 13 days, the counts rapidly increased to the original level and then continued to grow slowly. The yeasts studied by Murdock and DuBois *(11)* showed the same effect when grown in 42° Brix at 40° F.; that is, viable numbers decreased with time to approximately a 30% reduction after 10-15 days, followed by definite growth.

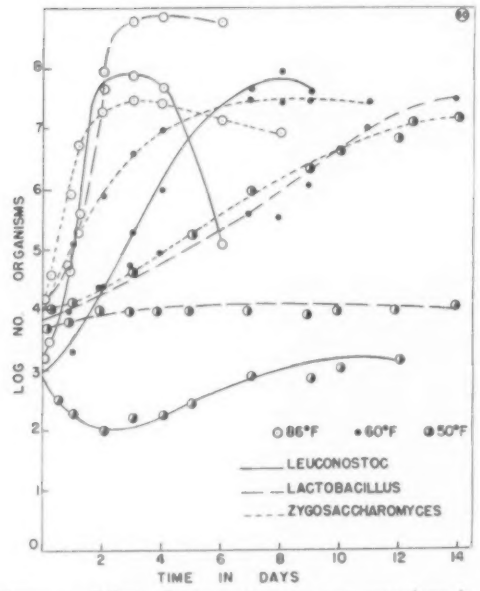

Figure 3. Effect of temperature on test organisms in 30° Brix orange juice concentrate.

A possible explanation for this behavior might be that by subjecting the organisms to an extremely unfavorable environment, they were injured progressively and temporarily so that no growth on agar occurred. Then as adaption of all cells took place, the numbers of viable organisms as determined by plate counts returned to the original level at a rate which apparently was not consistent with the subsequent growth curve. A similar observation was reported by Hegarty and Randall *(8)*, who found that *Escherichia coli*, maintained in the log phase by repeated subculturing, eventually went into a spontaneous lag phase in which the cells were injured to the extent that colonies would not form on nutrient agar.

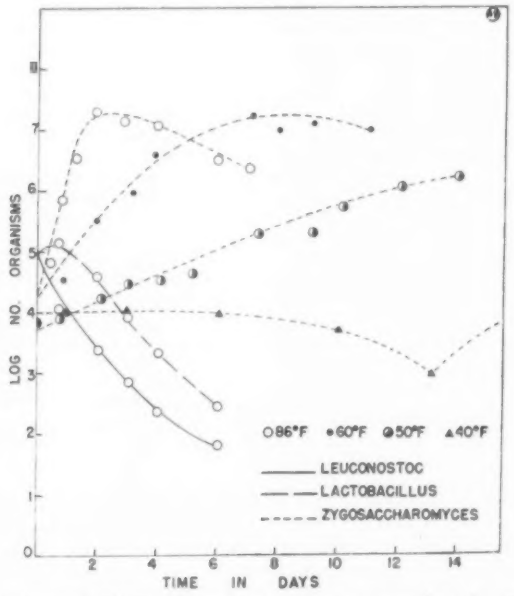

Figure 4. Effect of temperature on test organisms in 42° Brix orange juice concentrate.

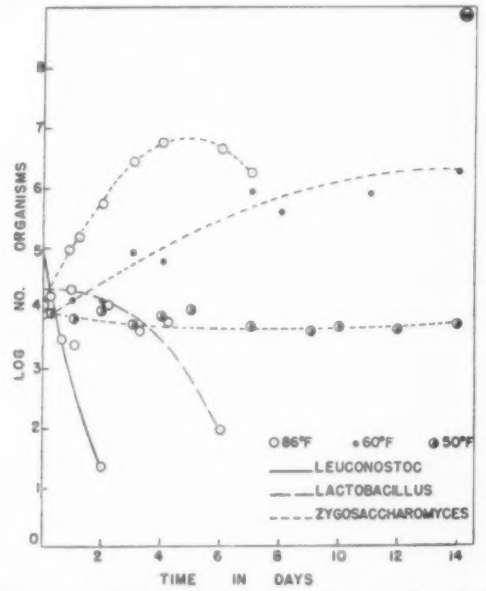

Figure 5. Effect of temperature on test organisms in 58° Brix orange juice concentrate.

TABLE 2
Lag phases of test cultures

Inoculating culture data (grown at 86° F.)			Test variable data		
Degree brix of inoculum	Age of inoculum (in hrs.)	Calculated viable count[1]	Degree brix test variable	Incubation temp. °F.	Lag time (in hrs.)
Lactobacillus plantarum var. mobilis					
12	24	108,000,000	12	86	0
20	24	85,000,000	20	86	0
30	48	430,000,000	30	86	16.3
12	24	1,240,000,000	12	60	8.6
20	24	450,000,000	20	60	7.2
30	24	42,000,000	30	60	0
12	24	820,000,000	12	50	82.5
20	24	650,000,000	20	50	67.0
Leuconostoc sp.					
30	48	610,000,000	12	86	2.4
30	48	610,000,000	20	86	3.6
30	48	610,000,000	30	86	12.0
12	24	665,000,000	12	60	7.2
20	24	600,000,000	20	60	9.6
30	24	100,000,000	30	60	13.5
12	24	460,000,000	12	50	28.8
20	24	450,000,000	20	50	24.0
Zygosaccharomyces vini					
12	24	1,030,000	12	86	0
20	24	270,000	20	86	0
30	48	41,000,000	30	86	0
42	48	8,300,000	42	86	0
42	48	8,300,000	58	86	0
12	24	1,120,000	12	60	0
30	24	2,720,000	20	60	0
30	24	2,720,000	30	60	0
30	24	2,720,000	42	60	0
30	24	2,720,000	58	60	0
12	24	2,600,000	12	50	0
20	24	1,200,000	20	50	0
30	24	12,000,000	30	50	28.8
30	24	12,000,000	42	50	0
12	24	1,100,000	12	40	216
20	24	540,000	20	40	180
30	24	2,400,000	30	40	156
30	24	2,400,000	42	40	384

[1] Calculated from factor by which original direct-counted inoculum was diluted and resulting initial viable plate count in test sample.

It is common knowledge within the frozen orange concentrate industry that adequate sanitary practices are necessary for the production of a high quality product; thus, the elimination of unsound fruit will significantly lower the microbiological load in freshly extracted juice since such fruit is known to contain very high levels of contaminating organisms *(1, 7, 12, 14)*. In spite of efficient fruit control measures, large numbers of spoilage organisms are invariably present in fresh juice and are potentially hazardous. The present study has yielded precise data as to growth rates of three organisms typical of those causing spoilage in frozen orange concentrate. These findings will provide a means for the more complete understanding of adequate sanitation essentials which have been previously rather well defined *(2)*.

The effect of temperature on the growth rates indicates that microbial growth in juice and low Brix concentrate may be greatly retarded at temperatures below 60° F. The chilling of evaporator feed and cut-back juice to 40° F., and operating the low Brix (12° to 30°) stages of evaporators at 60° F. would effectively reduce potential spoilage problems. In the Florida citrus industry, juice room equipment should be flushed frequently during the latter part of May and during June, since optimum conditions for the growth of citrus spoilage organisms exist at these times.

Because the data obtained in this study were based on the use of pure cultures, it may not lend itself to direct correlation with commercial conditions where a mixed flora exists; however, it is felt that the generalizations which have been derived from this basic information are fundamentally valid with respect to commercial operations. It was beyond the scope of this investigation to determine the effect of mixed cultures which exist in a multiplicity of combinations under commercial operations.

Equally important to the rate of bacterial growth in orange concentrate is the rate of diacetyl production, the accumulation of which results in the typical "buttermilk" off-flavor and odor. Unpublished work conducted in this laboratory demonstrated that of two *Lactobacillus* strains tested, one produced diacetyl at about 165 times the rate of the other, although its growth rate was considerably slower. Further studies would seem warranted on the correlation of rate of growth of lactic acid bacteria and the rate of diacetyl production.

SUMMARY

Growth curve characteristics in orange juice and concentrate were determined for three different types of organisms previously implicated in product spoilage: namely, *Leuconostoc sp.*, *Lactobacillus plantarum* var. *mobilis*, and *Zygosaccharomyces vini*. These organisms were grown at 86° F., 60° F., 50° F., and 40° F. in 12°, 20°, 30°, 42°, and 58° Brix concentrations thereby covering virtually all conditions encountered in commercial production of orange concentrate which are hazardous from the standpoint of spoilage.

From the 45 separate growth curves determined in these studies, the following general observations were made:

(1) The lag phase of microorganismal growth was independent of the growth conditions and was a function of only the nature of the inoculating culture.

(2) A decrease in growth temperature from an optimum of 86° F. resulted in a decrease in the growth rate of the three organisms tested.

(3) An increase in the degree Brix from optimums of 12° and 20° resulted in a decrease in the growth rate of the three organisms tested.

(4) Both the *Leuconostoc* and the *Lactobacillus* strains tested did not grow at 40° F. regardless of the degree Brix and did not grow at 42° Brix regardless of the temperature. At 40° F., the yeast grew slowly in all concentrations through 42° Brix.

(5) *Leuconostoc sp.* under the most favorable conditions of Brix and temperature was capable of attaining a concentration of approximately a billion organisms per ml. in 24 hours from an initial concentration of only 10,000 organisms per ml.

Acknowledgments

The authors express their appreciation for the helpful suggestions made by D. I. Murdock and C. H. Brokaw, Minute Maid Corporation, and V. S. Troy, Continental Can Company, Inc., in planning these investigations.

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Thermal Resistance of Putrefactive Anaerobe No. 3679 Spores in Vegetables In the Temperature Range of 250-290° F.[a, b]

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(Manuscript received June 13, 1956)

AN INVESTIGATION OF THE THERMAL RESISTANCE of Putrefactive Anaerobe No. 3679 (P.A. 3679)[d] by Pflug and Esselen *(2, 3)* has been extended to observe thermal destruction characteristics of this organism in the temperature range of 250° to 290° F. in vegetables. Data were obtained with these spores in fresh or frozen asparagus, green beans, corn, peas, spinach, and squash. Additional data were obtained on samples of these products after having been canned in order to determine the effect of a prior heat treatment and accompanying decrease in pH value on the thermal resistance of bacterial spores.

EXPERIMENTAL

Preparation of vegetable substrates. The fresh and frozen vegetables were cut up, diluted with two parts by weight of distilled water, and pureed for 5 minutes in a Waring blender. The puree was then strained through 4 layers of cheesecloth. Twenty-five ml. aliquots of these purees were placed in sterile bottles containing glass beads and stored at 35° or 0° F. Just prior to use they were inoculated with P. A. 3679 spores at a concentration of 10,000 spores per 0.01 ml. In the case of canned vegetables, portions of the same lot of fresh or frozen product were canned in water in No. *2* size cans and processed at 240° F. according to processing schedules in National Canners Association Bulletin 26-L. A record was kept of the amount of water added to each can. When the canned products were pureed sufficient water was added to give a final dilution of one part vegetable to two parts water by weight. The pH value of each substrate was determined with a Beckman Model G pH Meter.

Determination of thermal resistance. The thermal resistance of the P.A. 3679 spores in the different vegetable substrates and in neutral phosphate buffer and distilled water was determined at temperatures of 270°, 275°, 280°, 285°, 290° F. using a thermoresistometer and procedures as previously described by Pflug and Esselen *(2, 3)*. Amounts of 0.01 ml. of the various substrates containing 10,000 spores, each were added to each thermoresistometer cup. Twenty-four samples were heated at each time and temperature interval. At least seven time intervals were used at each temperature. In some cases tests were also made at temperatures of 250° and 260° F. The heated samples were subcultured in liver broth which was pre-stratified with a mineral oil-paraffin mixture. The tubes were incubated for 8 weeks at 90° F.

Treatment of data. D values (time for 90% destruction of the spores) were calculated according to the method described by Stumbo, Murphy and Cochran *(7)*, and by the method suggested by Schmidt *(5)*. In this latter procedure, the D values are calculated on a basis of the total data acquired during an experiment. The probability of sterility is plotted against time upon arithmetic probability paper. The time corresponding to L.D. 50, or the point on the curve where the probability of a tube being viable or sterile is equal to 0.5, is assumed to represent a survival level of 0.69 spore per tube. The D value is then calculated according to the formula:

$$D = \frac{\text{Time (L.D.50)}}{\log \text{initial number of spores per tube} - \log 0.69}$$

Survival and destruction end point curves were also made and extended to 250° F. The F and z values of these curves were obtained.

RESULTS AND DISCUSSION

Results obtained are summarized in Table 1 and Figures 1, 2, 3, and 4. After working with the first five fresh and frozen products (Table 1) tests were set up with new samples of vegetables to observe the effect of a prior heat treatment (canning) on the thermal resistance of P. A. 3679 spores. It is well known that during canning a decrease in pH value and other changes occur in vegetables.

Sognefest, Hays, Wheaton and Benjamin *(6)* showed that thermal processing of nonacid foods tends to lower the pH and that, in general, the higher the pH of the product before heating the greater the effect of heat in lowering the pH. The higher temperature equivalent processes caused less pH reduction than did the lower temperature processes in the range 260° to 230° F. It was further indicated that the lower the pH of a raw vegetable within the range 4.5 and 9, the lower the sterilizing value needed to insure a commercially sterile product. Thermal death time tests were carried out on fresh vegetable purees to which various amounts of HCl and NaOH were added in order to modify the natural pH values.

As has been observed by Reynolds, Kaplan, Spencer and Lichtenstein *(4)* and Schmidt *(5)*, it was found (Table 1) that z and D values calculated by the methods of Stumbo, Murphy and Cochran *(7)* and Schmidt *(5)* were generally in good agreement although some exceptions are apparent. Thermal resistance curves obtained by plotting D values [calculated by method of Stumbo, Murphy, and Cochran *(7)*] against temperatures are shown in Figures 1, 2, 3, and 4. These curves tend to follow a straight line and indicate a logarithmic order of destruction in the temperature range of 250° or 270° to 290° F.

Further examination of the data and the above curves suggested that in some products a straight line plotted in the temperature range of 250° to 270° or 275° F. had a slightly steeper slope or lower z value than such a curve plotted in the temperature range of 270° or 275° to 290° F. Because only limited amounts of data were obtained in the temperature range of 250° to 270° F., it was impossible to make a more complete analysis of these observations. However, based on such data as were available thermal resistance curves were plotted in the range of 250° to 270° F. and 270° to 290° F. and

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 11, 1956.

[b] Contribution No. 1053, of the University of Massachusetts College of Agricultural Experiment Station, Amherst, Mass.

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[d] A putrefactive anaerobe isolated by the National Canners Association Research Laboratories.

TABLE 1

Thermal death time characteristics of P. A. 3679 spores in pureed vegetables, distilled water, and neutral phosphate buffer in the temperature range of 250° to 290° F.

No.	Product	pH	D value (Stumbo's Method) Temperature (°F.) 250	260	270	275	280	285	290	z	D value (Schmidt's Method) Temperature (°F.) 250	260	270	275	280	285	290	z	E. P. Method F	z
1	Green beans, fresh	5.85	.....	.....	.0714	.0308	.0260	.0108	.0078	18.4	.....	.....	.0536	.0310	.0216	.0115	.0072	23.3	3.20	23.0
2	Corn, frozen	7.20	.....	.....	.0500	.0321	.0168	.0109	.0070	21.8	.....	.....	.0524	.0274	.0151	.0087	.0061	20.7	2.60	22.0
3	Peas, frozen	6.95	.....	.....	.0824	.0388	.0190	.0121	.0078	18.8	.....	.....	.0842	.0372	.0195	.0166	.0079	19.0	4.20	22.0
4	Spinch, frozen	6.69	.....	.....	.0908	.0493	.0246	.0161	.0103	20.0	.....	.....	.0943	.0457	.0245	.0165	.0099	20.6	7.00	18.8
5	Hubbard squash, fresh	5.73	.....	.....	.0365	.0253	.0161	.0099	.0064	26.5	.....	.....	.0365	.0252	.0156	.0091	.0055	23.0	1.40	27.7
6	Green beans, frozen	6.03	.....	.....	.0529	.0320	.....	.0106	.0079	22.8	.....	.....	.0572	.0322	.....	.0113	.0072	22.1	3.00	22.2
7	Green beans, canned	5.82	.....	.....	.0490	.0281	.....	.0095	.0061	22.0	.....	.....	.0517	.0288	.....	.0096	.0060	21.6	2.85	19.9
8	Asparagus, frozen	6.15	.....	.....	.0456	.0252	.0146	.0092	.0060	22.4	.....	.....	.0445	.0248	.0148	.0073	.0047	20.0	2.10	24.6
9	Asparagus, canned	5.65	.....	.....	.0445	.0298	.0144	.0099	.0056	21.9	.....	.....	.0445	.0312	.0143	.0099	.0049	20.9	2.05	24.1
10	Green beans, fresh	6.00	.932	.282	.0419	.0283	.0153	.0080	.0045	16.2	.997	.262	.0404	.0277	.0163	.0084	.0044	17.1	6.0	19.6
11	Green beans, canned	5.70	.751	.196	.0416	.0229	.0129	.0090	.0055	22.2	.769	.205	.0428	.0248	.0128	.0091	.0052	17.8	4.3	19.6
12	Carrots, fresh	6.18	1.115	.234	.0530	.0373	.0190	.0114	.0064	18.4	1.000	.252	.0560	.0340	.0190	.0110	.0068	18.2	5.3	19.6
13	Carrots, canned	5.48	.777	.190	.0503	.0257	.0169	.0096	.0059	19.6	.794	.208	.0524	.0281	.0181	.0101	.0059	18.8	4.7	19.9
14	Corn, frozen	6.64	1.099	.....	.0582	.0310	.0190	.0120	.0065	17.8	1.033	.....	.0590	.0312	.0192	.0115	.0063	19.0	6.50	18.9
15	Corn, canned	6.48	.....	.....	.0506	.0270	.0118	.0105	.0063	20.5	.....	.....	.0472	.0273	.0157	.0108	.0068	21.3	2.30	23.7
16	Peas, frozen	6.75	.....	.....	.0702	.0407	.0211	.0135	.0076	21.0	.....	.....	.0740	.0411	.0215	.0130	.0073	19.9	4.50	20.7
17	Peas, canned	6.27	.....	.....	.0452	.0259	.0150	.0105	.0062	23.0	.....	.....	.0425	.0264	.0154	.0083	.0046	20.4	3.15	22.6
18	Spinach, frozen	6.56	.997	.254	.0629	.0353	.0155	.0098	.0064	17.5	1.100	.260	.0722	.0361	.0151	.0091	.0062	18.0	5.60	20.4
19	Spinach, canned	5.55	.....	.227	.0684	.0308	.0164	.0110	.0053	18.5	.....	.227	.0541	.0313	.0172	.0108	.0055	19.7	4.20	21.3
20	Distilled water		.938	.224	.0511	.0326	.0173	.0115	.....	18.8	.938	.235	.0505	.0235	.0173	.0106	.....	19.0	4.80	19.0
21	Neutral M/15 phosphate buffer	7.00	2.033	.723	.1860	.0931	.....	.0271	.0159	18.9	1.984	.817	.192	.0957	.....	.0276	.0162	17.8	14.00	19.2

their z values compared as summarized in Table 2. Curves showing these relationships of fresh carrots are presented in Figure 5. Consideration has been given to the reason for this apparent change in slope of thermal resistance curves at temperatures above 270° F. Thermal resistance data in the temperature range of 220° to

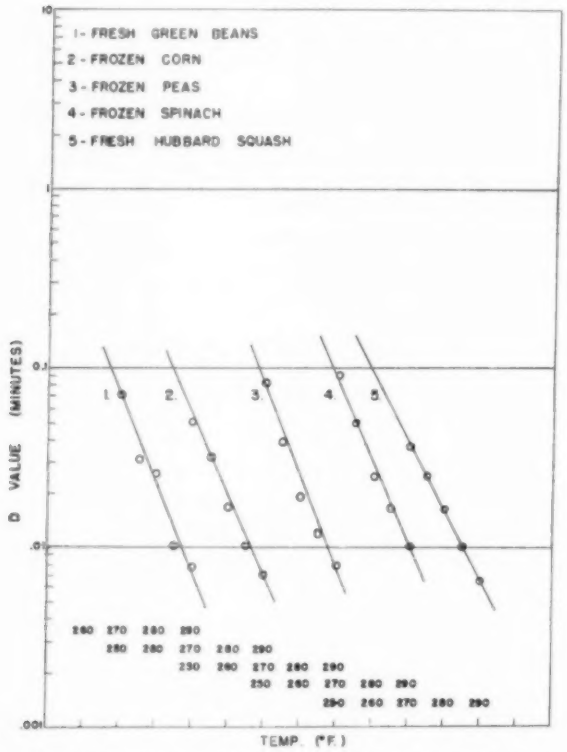

Figure 1. Thermal resistance curves for P. A. 3679 spores in fresh green beans, frozen corn, frozen peas, frozen spinach, and fresh Hubbard squash.

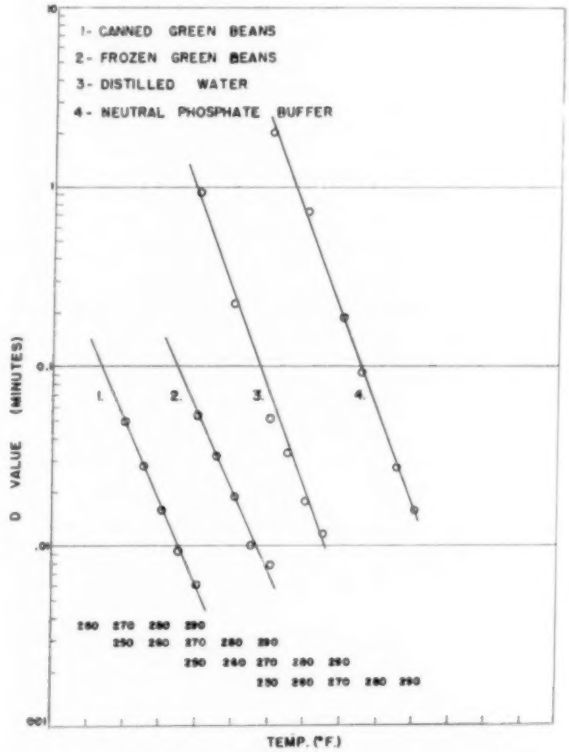

Figure 2. Thermal resistance curves for P. A. 3679 spores in canned green beans, frozen green beans, distilled water and neutral phosphate buffer.

270° F. as presented by Stumbo, Murphy and Cochran *(7)* indicated a good straight line relationship. The z values for their curves and the data as reported by others are of the magnitude of those shown in Table 2 for temperatures from 250° to 270° F. Explanations for this apparent change in z value at temperatures above

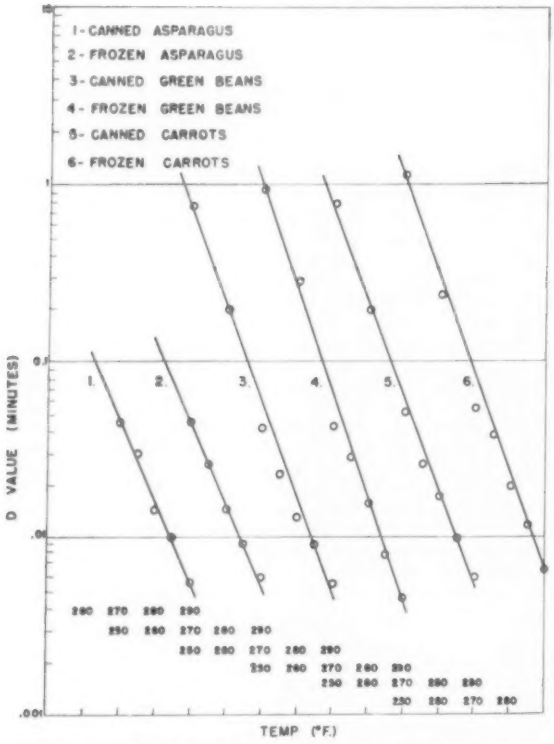

Figure 3. Thermal resistance curves for P. A. 3679 spores in canned and frozen asparagus, green beans, and carrots.

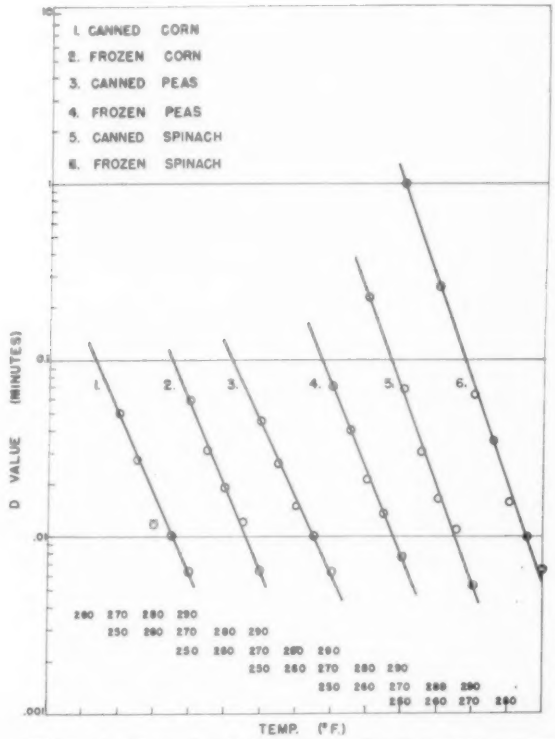

Figure 4. Thermal resistance curves for P. A. 3679 spores in canned and frozen corn, peas, and spinach.

270° F. can be postulated. It is possible that chemical changes that occur in vegetables during longer holding periods at lower temperatures may exert an influence on spores which does not occur at higher temperatures with very short holding times. Secondly, although every effort has been made to maintain heating with saturated steam in the thermoresistometer, if at the higher temperatures a dryer steam were encountered it might contribute to an increased z value as has been reported by Collier and Townsend *(1)* in the case of superheated steam.

TABLE 2

Comparison of z values of thermal death time curves of P. A. 3679 spores in the temperature ranges of 250° to 270° F. and 270° to 290° F.

Product	z value D values (Stumbo)		z value D values (Schmidt)	
	250°-270° F.	270°-290° F.	250°-270° F.	270°-290° F.
Fresh green beans	14.6	18.8	14.4	20.8
Canned green beans	16.2	22.3	15.9	22.2
Fresh carrots	15.1	21.2	15.8	21.8
Canned carrots	16.8	21.8	16.8	21.3
Frozen corn	15.7	21.4	16.2	20.8
Frozen spinach	16.5	22.7	16.7	25.8
Canned spinach	18.6	18.6	15.4	21.2
Average	16.2	21.0	15.9	22.0

Such apparent changes in z values at high temperatures do not necessarily mean that there is a deviation from a logarithmic destruction rate per se. Application of the logarithmic destruction rate theory assumes spores of uniform heat resistance heated in a medium which remains constant in composition and reaction

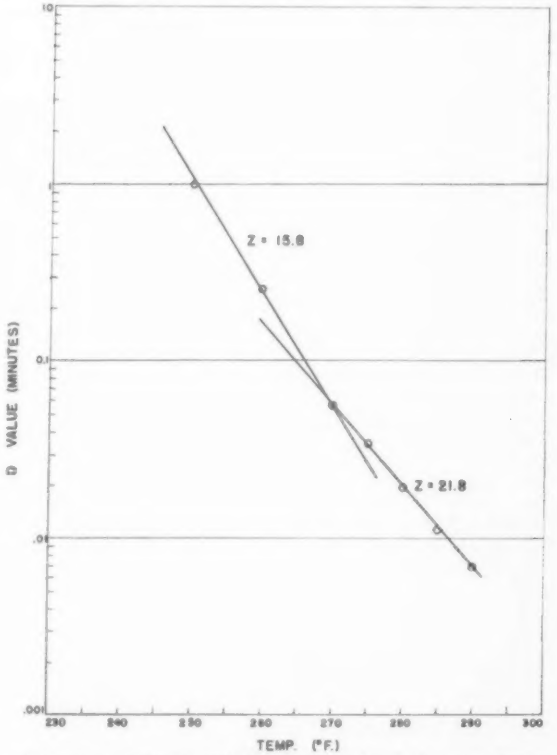

Figure 5. Thermal resistance curves for P. A. 3679 spores in fresh carrots illustrating difference in z values in temperature range of 250° to 270° F. and 270° to 290° F.

during the heat treatment. From a consideration of known and unknown changes that occur in foods during heating and the reaction rates of such changes, it is apparent that we are not dealing with a static heating substrate. Under these conditions, it seems reasonable to expect that such alterations in a food during heating could exert an influence on the apparent thermal destruction rate of bacterial spores. A comparison of the F values for fresh or frozen and previously canned vegetables illustrates the effect of extreme degrees of heating on the thermal resistance of spores in a food.

SUMMARY

Thermal resistance data for P.A. 3679 spores in fresh, frozen, and previously canned vegetables were obtained in the temperature range of 250° to 290° F. In general, the spores exhibited a lower degree of heat resistance in previously canned vegetables than in the fresh or frozen product. Spore destruction times tended to follow a semi-logarithmic destruction rate in the temperature range investigated. However, it appeared that there may be some changes in the destruction rate at temperatures above 270° F. It is suggested that such changes in spore destruction rates may be due to the influence of chemical changes occurring in food during heating.

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Organoleptic Evaluation of Applesauce Fortified with Essence and Citric Acid[a]

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(Manuscript received April 16, 1956)

Color, consistency and finish are quality characteristics which have been well standardized in the modern methods for manufacturing applesauce. However, there is a variation in flavor during the season because of varietal differences of apples for blending and the normal fluctuations in fruit maturity. Apple essence, prepared by the process developed at the Eastern Regional Research Laboratory *(3, 4)* was added to applesauce to stabilize the flavor level. Citric acid was added to increase the tartness.

EXPERIMENTAL PROCEDURE

Preparation of samples. Three types of essence were used. Two of the essences were from the same varieties of apples as were used for the sauce, one from the whole apples and one from the peels and cores. The third essence was from whole apples of the dessert type. The dessert blend contained Stayman Winesap (43%), MacIntosh (20%), Northern Spy (15%), and Baldwin (11.5%), plus small quantities (0.5%) of Jonathan, Grimes Golden, and Golden Delicious. Essence was added at various levels of concentration from 0.5- to 5.0-fold.[c] In addition, citric acid, in concentrations of 0.1 and 0.2%, was added to some of the samples.

The applesauce was prepared from 4 parts of York Imperial, 1 part of Stayman Winesap, and 1 part of Rome Beauty apples at the Chambersburg, Pa., plant of Knouse Foods Cooperative, Inc., using standard commercial equipment. The essence (150-fold[d]) was injected into the center of the cans of hot sauce, prior to closing, by means of a hypodermic syringe equipped with a long needle. The citric acid was added as a 50% solution. Applesauce from the same production line was used as control. The sauce was stored at 70° F. and samples removed for taste evaluation after 1 month and after 10 months.

Evaluation of samples by trained panel. For the evaluation, a panel of 20 judges and 8 alternates was selected from 55 candidates on the basis of the consistency of their judgment in scoring applesauce. This was determined in 2 training sessions and 4 panel-selection sessions, using the same type of sauce samples and the same scoring methods as those to be used later in the actual evaluation.

For panel evaluation, 27 experimental samples were arranged in 6 series as indicated in Table 1. An incomplete block design would have been more suitable for making comparisons between samples in different series, but this was not possible because of the difficulty of preserving samples once they were opened.

Samples in each series were coded and presented in a randomized order. Judges were asked to score the samples on a 10 to 1 scale (10 = *best* and 1 = *poorest*). A sample of the control, arbitrarily given the score of 5, was included for the purpose of comparison but this value was not used in the tabulation of results. A hidden control sample was also included in

[a] Presented before the Fifteenth Annual Meeting, Institute of Food Technologists, Columbus, Ohio, June 15, 1955.

[b] A laboratory of the Eastern Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

[c] Fold was calculated as the ratio of the volume of the juice from which the essence was prepared to the weight of the sauce to which it was added: e.g., 1 pound of 150-fold essence added to 150 pounds of sauce would equal 1-fold essence.

[d] Fold of essence is the ratio of the volume of the juice to the volume of essence obtained from it.

TABLE 1

Flavor scores for applesauce after 1 month

Series	Type of essence added	Added citric acid	Average taste panel score							F value	LSD P = .05
			Hidden control	Added essence-fold							
				0	0.5	1	2	3	5		
A	Sauce blend	none	5.2	....	6.2	5.8	7.8	8.3	....	14.8**	1.0
B	Sauce blend	0.2%	5.1	5.5	5.0	5.3	6.0	5.7	....	ns	
C	Peels and cores	none	5.4	....	5.7	6.8	6.6	7.6	7.3	4.8**	1.1
D	Peels and cores	0.1%	5.1	5.2	6.7	6.8	6.3	7.9	....	7.5**	1.1
E	Peels and cores	0.2%	5.2	5.1	6.4	6.2	6.5	6.4	....	ns	
F	Dessert blend	none	5.1	....	6.0	6.4	7.0	....	....	3.6*	1.2

ns—not significant at 5% level.
*—significant at 5% level.
**—significant at 1% level.

each series. The score of the hidden control was used in the analysis of the data because it was felt that it would reflect any bias in scoring. Data were summarized and subjected to analysis of variance.

Evaluation of samples by consumer panel. The consumer panel consisted of approximately 150 members of the laboratory and office staff selected at random. For each test, the panel members were presented with 2 coded samples: a sample of fortified sauce and a sample of the control, and asked to state their preference. Order of presentation was varied so that the control was presented first to approximately 50% of the judges in each test. In the first few tests the code letters were written on the bottom of the sample cups so that the judges would not be influenced. In later tests, code letters of equal degree of bias were used as recommended by Ishler *et al.* (2).

RESULTS

Results of the initial flavor evaluation of sauce samples after one month's storage are recorded in Table 1. Each score is the average of 20 judgments. The 6 series differ in the type of essence used and in the presence or absence of added citric acid. Each of the 3 essences alone (Series A, C and F) gave a significant flavor improvement starting with 0.5- or 1.0-fold and increasing as the quantity of essence was increased. The one sample containing 5-fold essence showed no flavor improvement over the 3-fold level, and many of the judges remarked that this sample had a medicinal flavor.

Addition of 0.1% citric acid with various levels of essence gave flavor scores not significantly higher than the corresponding series containing no added acid. Samples containing 0.2% added acid showed no flavor improvement. Samples with added acid evoked a mixed response from the taste panel; some tasters preferred a tart sauce while an equal number of tasters objected.

The taste panel evaluation of the sauce after 10 months' storage (Table 2) shows a slight decrease in flavor. This may have resulted from an actual loss of essence or from the masking effect of off-flavors. Only two series (D and F) now show flavor improvement at the 5% level of significance. Data obtained on similar samples by a taste panel consisting of 4 members of the quality control laboratory of Knouse Foods Cooperative, Inc., agreed closely with the results recorded in Tables 1 and 2.

In order to gain a better comparison between samples from the 6 different series, the panel was asked to evaluate the samples containing 2-fold essence. This was done at both the 1-month and the 10-month storage periods (Table 3). In this comparison, the "peel and core" essence and the sauce blend essence rated very high, but the "dessert blend" rated very low. The sauce containing 0.1% added citric acid rated high at one month but not at 10 months. This latter result appears to be erroneous because subsequent tests by both trained and consumer type panels have shown that this combination of additives held up very well on storage. In general, any flavor improvement persisted during 10 months' storage at 70° F.

TABLE 3

Comparison of sauce samples containing 2-fold essence

Series	Type of essence added	Added citric acid	Avg. score after storage	
			1 month	10 months
A	Sauce blend	none	6.7	6.4
B	Sauce blend	0.2%	4.5	4.9
C	Peels and cores	none	6.7	6.6
D	Peels and cores	0.1%	6.8	5.7
E	Peels and cores	0.2%	5.2	5.6
F	Dessert blend	none	4.9	4.6
G	Hidden control	none	5.2	5.3

Consumer preference studies were made on a few of the more promising samples to determine the quantity of essence required to give a significant flavor improvement. Figure 1 shows the percentage of preference for sauce fortified with 3 levels of essence from peels and cores. The sauce containing 1.25-fold essence was a mixture of equal parts of sauce containing 0.5- and 2.0-fold. The dotted line represents the percentage of preference required for significance (P = .05) as calculated by the formula of Boggs and Hanson (1). By interpolation it was found that slightly less than 1.5 fold essence would be required to give a preference at the 5% level of significance. By referring to Table 1 it can be seen that the trained panel found a significant flavor improvement with peel and core essence at a level below 1-fold.

Sauce containing 1.25 fold peel and core essence was submitted to the consumer panel again after 10 months' storage.

TABLE 2

Flavor scores for applesauce after 10 months

Series	Type of essence added	Added citric acid	Average taste panel score							F value	LSD P = .05
			Hidden control	Added essence-fold							
				0	0.5	1	2	3	5		
A	Sauce blend	none	5.7	....	6.5	6.8	6.3	6.7	....	ns	
B	Sauce blend	0.2%	5.4	4.8	5.5	4.4	5.5	5.4	....	ns	
C	Peels and cores	none	5.6	....	6.6	6.0	6.9	7.1	7.1	ns	
D	Peels and cores	0.1%	5.1	5.5	6.1	7.0	5.6	7.1	....	2.6*	1.4
E	Peels and cores	0.2%	5.3	4.9	6.5	6.2	5.7	6.4	....	ns	
F	Dessert blend	none	5.0	....	5.6	6.2	6.5	....	....	5.7**	1.1

ns—not significant at 5% level.
*—significant at 5% level.
**—significant at 1% level.

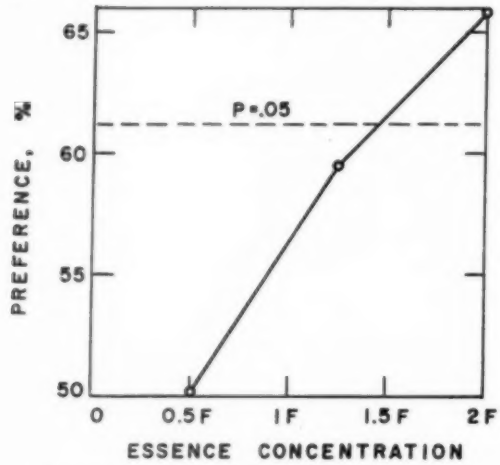

Figure 1. Consumer panel rating of apple sauce.

The panel preference was 64.3%, indicating that there was very good flavor retention.

The following season, 1954-55, a quantity of sauce was prepared containing 2-fold "peel and core" essence plus 0.1% citric acid. An untrained panel of 180 judges showed a preference of 59.5% for this sauce after one-month of storage, and 74.7% after 6 months. These results confirm the stability of the flavor improvement during storage.

DISCUSSION

Essence derived from apple peels and cores appears to be as good as that derived from whole apples for fortifying the flavor of applesauce. Peels and cores constitute a sizeable byproduct of the manufacture of sauce and the various sliced-apple products. The usual ratio between these products and peels and cores is 2:1. Thus, a plant preparing sauce could produce enough essence from these byproducts to fortify the entire pack at the 0.5-fold level, or one-third of the pack at a level of 1.5-fold.

At the present price of apple essence ($5 per gal. of 150-fold, 1955-56 season) it would cost 12 cents per case of No. 303's to fortify sauce at the 1.5-fold level. Addition of 0.1% citric acid would cost an additional 2.1 cents per case. In a plant producing both sauce and essence it is quite possible that the essence could be prepared at a cost somewhat below the current market quotation.

The mechanics of adding essence or citric acid to sauce should not be difficult. There are several machines available for adding measured amounts of a liquid to individual containers at a high rate of speed. However, it would probably be cheaper and more susceptible to accurate control to proportion the essence into the sauce stream before it reaches the filler.

Traditionally apple sauce has been a low-cost, low profit-margin item. The individual processor will have to decide if the improved product flavor would justify the added cost of manufacture.

SUMMARY

Applesauce flavor was improved by the addition of apple essence. The essence from peels and cores, a byproduct of sauce manufacture, gave satisfactory results. The flavor improvement diminished only slightly during 10 months' storage at room temperature.

Addition of 0.1% citric acid gave a pleasant tartness to the sauce but 0.2% added citric acid made the sauce too tart for most tasters.

Approximately 1.5-fold added essence was required to show a significant flavor improvement as judged by a small consumer panel.

Acknowledgments

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We also want to thank the members of the taste panels for their faithful cooperation.

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Use of Antibiotics in Prolonging Storage Life of Dressed Chicken[a, b]

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(Manuscript received June 13, 1956)

THE PRESENT STUDY was undertaken to determine the extent to which antibiotic treatment would delay the growth of microorganisms indigenous to dressed poultry. Since the time that the current work was initiated, studies by Kohler *et al. (5)*, and by Ziegler and Stadelman *(6)* have been reported in the literature. Kohler *et al. (5)* placed whole or cut-up birds in water containing 0, 3, 10 or 30 p.p.m. chlortetracycline for times varying from five minutes to 24 hours and then stored the chicken at 3° C. They estimated the bacterial population on the chicken at weekly intervals by quantitatively sampling the water used to rinse the birds. These workers concluded that the time needed for microbial populations to reach about 10^7 cells per gram was 7 days for the control birds as opposed to 14-21 days for chickens treated with water solutions containing 10 or 30 parts per million (p.p.m.) chlortetracycline. They indicated that the poultry receiving antibiotic treatment remained fresh and edible significantly longer than did the untreated controls. Ziegler and Stadelman *(6)* observed the average times in which fryers treated with 0, 10, 20 or 40 p.p.m. chlortetracycline developed off-odor to be 11.6, 17.6, 18.4, and 18.9 days, respectively. For their study, they used half birds that had been cooled for 2 hours in water and ice prior to the ten minute antibiotic dip.

The present observations are in general agreement with the results reported by the workers cited above. However, this work includes information on the effects of a number of other antibiotics in addition to chlortetracycline. Also, earlier results from this laboratory *(1)* demonstrated that loads of microorganisms in excess of 10^7 organisms per sq. cm. were associated with the appearance of off-odor and slime. The occurrence of off-odor and slime were taken as signs of spoilage in untreated birds and it was considered of interest to determine if similar characteristics could be used to forecast spoilage on birds treated with antibiotics.

Consideration must be given to the amount of water absorbed by the birds. In commercial practice, birds are chilled in tanks containing water and ice. Bailey *(2)* made an extensive study of the water absorption during the "slush-chilling" of birds and concluded that during 135 minutes of chilling the average water uptake by the whole bird was 7.4% and for the cut-up birds 9.4% of the original weight.

PROCEDURE

The antibiotics tested included chlortetracycline, oxytetracycline, tetracycline, streptomycin, neomycin, mycostatin, aerosporin, A-5288 (Lederle), ascosin, and rimocidin.

In preliminary trials 1, 3, 10, 30, 90 and 270 p.p.m. of chlortetracycline (CTC) and 3, 10, and 30 p.p.m. of oxytetracycline (OTC), tetracycline (TC), and streptomycin were tried. In later tests, the antibiotics were used at a level of 10 p.p.m. only.

Whole or cut-up chickens were obtained from a commercial poultry processing plant and brought to the laboratory for treatment. Most of the lots of birds tested were 2-2½ lb. fryers. For several of the trials, it was necessary to use birds weighing 3-4 lbs. The birds were killed, semiscalded (58-60° C.), plucked, eviscerated and washed but not iced at the plant. The chickens were kept chilled enroute by packing in polyethylene bags and covering the bags with chipped ice. These precautions were considered unnecessary for birds procured in Ames, since the poultry was transported to the laboratory immediately after killing.

In the laboratory, antibiotic solutions were prepared at the desired concentrations in water chilled to 1.7° C. Two liters of solution was used to dip the small birds and four liters for the large birds. The birds were held for two hours at 1.7° C. in the water or water-antibiotic solution, unless otherwise indicated.

For bacteriological samples, portions of the surface of the birds were sampled by the swab technique. This consisted of thoroughly rolling moist absorbent cotton swabs back and forth within an area outlined by sterile aluminum disks (see photograph). Bacteriological counts were also made after rapidly dipping the birds up and down 50 times in sterile water to remove the bacteria from the surfaces and sampling the rinse water.

Showing swab technique used for obtaining bacteriological samples from various portions of the surface of the birds.

Microbiological populations were determined after 0, 2, 4, 6, 8, 10 and 14 days or at 0, 1, 3, 5, 7, 10, 15 and 18 days storage at 4.4° C. in polyethylene bags. At the time of sampling, observations were made for the occurrence of the types as well as numbers of microorganisms present on the surface of the bird. Duplicate samplings and platings were made with each of the media used.

Enumeration was made using nutrient, "fluorescein," malt, and eosin methylene blue agars. Enrichment in selenite F for the detection of *Salmonella* was followed 16 to 18 hours later by streaking on brilliant green and bismuth sulfite agars. Agglutination tests with polyvalent antisera were made on colonies showing growth typical of *Salmonella* organisms.

The fluorescein agar used is the medium described by King *et al. (4)*. Malt agar was acidified with lactic acid to pH 4.5 to prevent the growth of bacteria and permit growth of yeasts. For some of the determinations for coliforms the most probable numbers technique as described in the "Standard Methods for the Examination of Dairy Products" was used.

[a] Journal Paper No. J-2971 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 1262.

[b] Presented at the 16th Annual Meeting of IFT, St. Louis, Missouri, June 12, 1956.

Nutrient agar plates were incubated at 15° C. for 4 days. Fluorescein and malt agar plates were incubated at 30° C. Fluorescein plates were read at 36-48 hours, while malt agar was incubated for 4 days; the other media were incubated at 37° C. for 24-48 hours. Counts were made with the aid of a Spencer colony counter.

The amount of water absorbed by the tissue was determined after immersion of the birds for ten seconds, for 10 minutes and for 2 hours. Tap water and solutions of CTC containing 3 or 30 p.p.m. CTC cooled to 1.7° C. were used for immersing the birds. For the ten second dip, the birds were submerged and withdrawn ten times. All birds were drained for one minute before weighing.

Residual chlortetracycline was determined by an adaptation of the method described by Grady and Williams *(3)*. Antibiotic assay disks were placed on the moist surface of the bird to soak up the fluid present. A period of approximately one minute was required to saturate the disk. An indication of the amount of antibiotic present in the fluid present on the skin was obtained by comparing these disks with standard solutions of chlortetracycline.

RESULTS AND DISCUSSION

An increase in weight of about 4.0% occurred in chickens that had been fully dressed but not placed in chill water when these birds were dipped for ten times (see Table 1). After 10 minutes an additional 1.0% gain was observed. After a two-hour chill time a further gain of 2.8% or a total gain of 7.8% occurred. The results at the end of 2 hours are in fairly good agreement with those reported by Bailey *(2)* for 135 minutes. The water absorptions that he found might be expected to vary somewhat from those reported here. In Bailey's procedure, water was not used to wash the surface or body cavity of the bird during evisceration as is commercially practiced. Also, the birds in his experiments were dried by wrapping in towels.

TABLE 1
Percent gain in weight of chicken immersed in water or antibiotic solution

p.p.m. CTC	Dipped 10 times	Immersed in Water	
		10 min.	120 min.
0	4.0	5.3	7.9
1	3.9	4.6	8.2
3	4.2	5.1	7.4
10	4.3	4.8	8.6
30	3.7	4.9	6.9
90	4.3	5.0	7.5
270	3.9	5.0	7.9
Av.	4.0	5.0	7.8
Dry picked bird	5.1	6.3	8.8

Not all replicate weighings (7-10 were used for each antibiotic concentration) gave results that were in close agreement. In several instances overestimates were obtained when liquid became entrapped between skin and flesh or between membranes and flesh.

It may be seen in Table 1 that no differences were observed for the amount of liquid absorbed by birds immersed in water as compared with those immersed in antibiotic solutions. Also, no evidence was found to indicate that when known levels of chlortetracycline were added to the immersion water, the antibiotic was differentially absorbed. The residual solution contained approximately the same level of CTC as that sampled immediately before immersion. However, after two hours in the chill water, there was an uptake of 70-90 g. of antibiotic solution by the small birds and from 110-125 g. by the large birds.

Filter pads placed on the skin surface of birds immersed in water containing 10 p.p.m. CTC indicated that the liquid absorbed by the pad had less than 2 p.p.m. residual antibiotic immediately after drainage and only 0.7 p.p.m. 1 hour later. Samplings from birds dipped in solution containing 30 p.p.m. CTC had an initial level of 12.4 p.p.m. CTC and 3.5 p.p.m. after 1 hour. However, at the end of 100 hours, there were residuals of 0.3 and 0.6 p.p.m. CTC for the initial 10 p.p.m. and 30 p.p.m. CTC solutions.

Antibiotic was still detectable by this assay procedure at the termination of a 21-day storage period. Antibiotic at the level of one p.p.m. was found in the tissue directly beneath the skin immediately after chilling and drainage.

Preliminary experiments wherein concentrations of CTC were used in an approximate geometric progression (0, 1, 3, 10, 30, 90, and 270) were conducted to test the effect of increasing amounts of the antibiotic on bacterial populations on the skin surfaces (See Figure 1). Total counts on chickens treated with 30 p.p.m. of CTC for two hours remained at about 100,000 for four days, while on control birds there were almost a million bacteria per sq. cm. of surface. With concentrations of chlortetracycline exceeding 3 p.p.m., no direct relationship was shown between the amount of antibiotic used and the number of organisms found on the surface of the bird. For example, at the end of two days of storage at 4.4° C., the relative bacteriostatic action of the various levels of CTC were as follows: $270 > 90 > 10 > 3 > 30 > 1 > 0$. However, after four days the order of inhibitive effect changed to $30 > 270 > 90 > 10 > 3 > 1 > 0$ and at seven days it was $30 > 90 > 270 > 3 > 10 > 1 > 0$. The con-

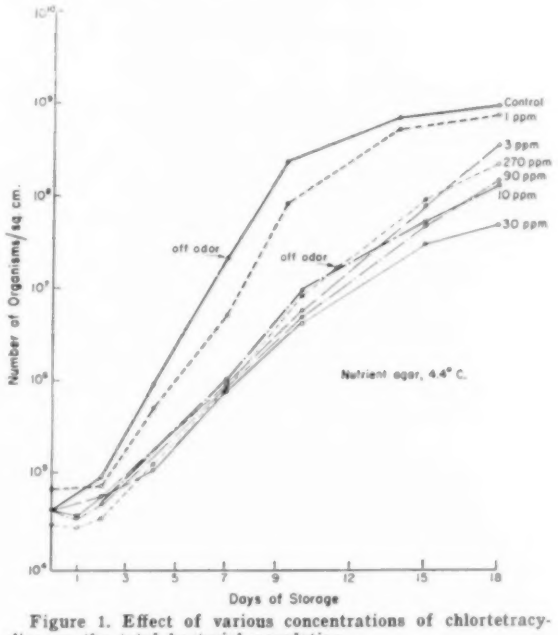

Figure 1. Effect of various concentrations of chlortetracycline on the total bacterial population.

trol birds had reached a population of 21 million per sq. cm. and had developed slime and off-odor by the seventh day, whereas these defects were not observed until the eleventh day on birds receiving antibiotic treatment.

Birds chilled in solutions containing one p.p.m. CTC developed off-odor and slime more quickly than did birds treated with higher concentrations of antibiotic. The skin, flesh, and bones of chickens chilled in solutions containing 90 or 270 p.p.m. CTC had a pronounced yellow-green cast. As a consequence of these undesirable results, the levels of antibiotic tested in subsequent treatments were limited to 3, 10, and 30 p.p.m.

A comparison of the rinse method and swab method for determining microbial populations showed that the increases in populations followed similar patterns (Figure 2). The counts as determined by the rinse method

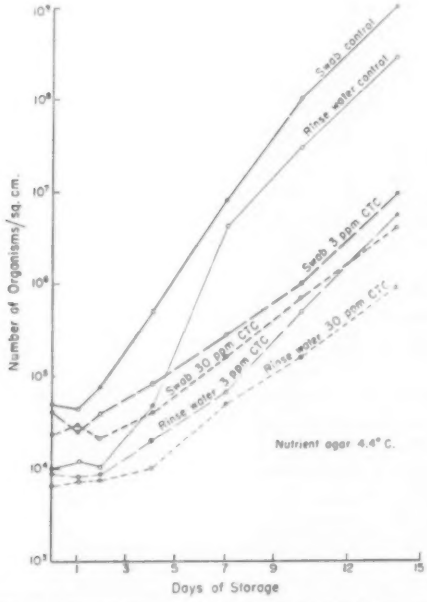

Figure 2. Comparison of total counts obtained by swab and by rinse methods of sampling.

were always at a lower level than those obtained by the swab method. However, there was a constant relationship between the numbers removed by the swab technique when compared with those recovered from the rinse water. Therefore, the assumption was made that either method was acceptable. The swab method was preferred and used routinely since it was more convenient to use and did not give underestimates.

Comparisons of the activity of the antibiotics, tetracycline, oxytetracycline, chlortetracycline, and streptomycin at levels of 3 and 30 p.p.m. are shown in Figures 3 and 4.

In these experiments 3 p.p.m. CTC provided a storage life of more than 11 days before counts reached 10 million while the other antibiotics repressed microbial numbers to this level for 7½-8 days. Control birds had populations exceeding 10 million before the seventh day. At levels of 30 p.p.m., counts were maintained at less

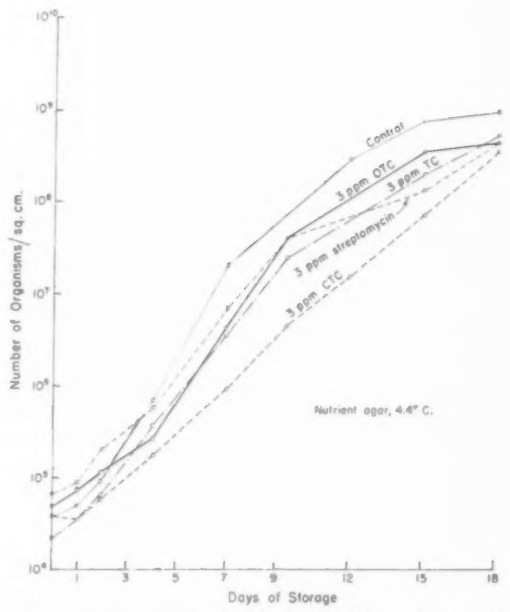

Figure 3. The effect of chlortetracycline, oxytetracycline, tetracycline and streptomycin at levels of 3 p.p.m. on total bacterial populations.

than 10 million organisms per sq. cm. for 12-13 days while the control had 20 million bacteria by the seventh day. Birds treated with streptomycin or tetracycline had 18 million and 42 million microorganisms by the tenth day.

When differential media were used to determine the incidence of organisms on chicken chilled in water containing 10 p.p.m. CTC, results in nutrient agar and

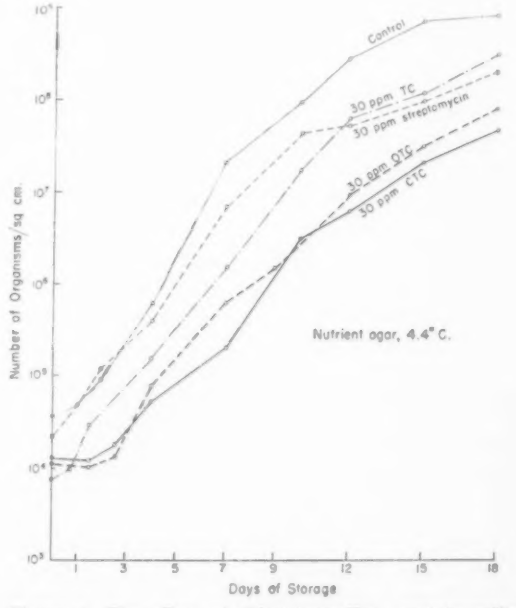

Figure 4. The effect of chlortetracycline, oxytetracycline, tetracycline and streptomycin at levels of 30 p.p.m. on total bacterial populations.

fluorescein agar were similar. Fluorescein agar gave excellent pigment formation for *Pseudomonas* species which produced fluorescein and, with few exceptions, the organisms recovered from this medium were gram negative rods. Some chromogens formed colonies during the first two or three days of storage but these were easily detected by their color characteristics. While the counts obtained on fluorescein agar were slightly lower than on nutrient agar, after 2 days the counts on the 2 media were comparable. It can be noted by comparing the curves in Figure 5 that there was destruction of miscellaneous flora when chicken was chilled in 10 p.p.m. CTC while the levels of organisms growing in fluorescein agar remained constant. The typical gram negative flora persisted but did not multiply during the first 3 days of storage. It is not known if these organisms were inhibited by small levels of antibiotic and later overcame bacteriostasis or if the CTC residual on the skin was reduced to a level that was innocuous.

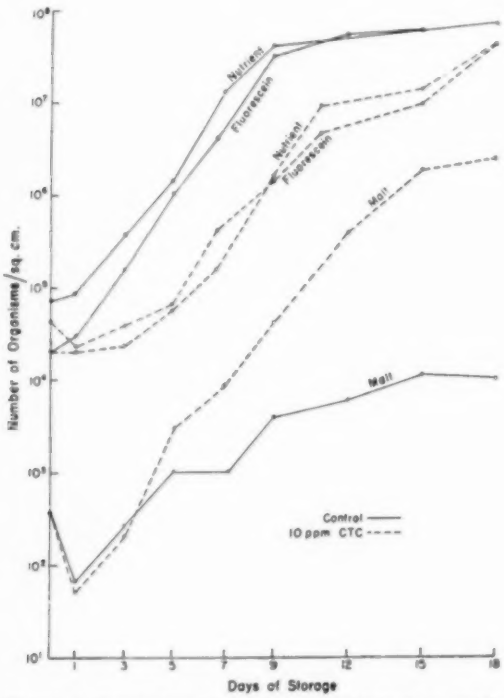

Figure 5. Comparison of total counts obtained on nutrient, fluorescein, and malt agars.

In Figure 6 are shown the proportions of the different kinds of bacteria on the controls and on birds treated with 10 p.p.m. CTC. At 2 days, 65% of the flora was found to be of the *Pseudomonas-Achromobacter* type while 95% of the organisms on the treated chicken belonged to this group. Tests conducted for determining the incidence of coliforms, chromogenic bacteria, staphylococci, *Salmonella*, *Bacillus*, and miscellaneous organisms revealed that the incidence of these several groups was largely restricted to birds not receiving antibiotic treatment. In control birds chromogenic bacteria were not isolated after the first 4-5 days when the

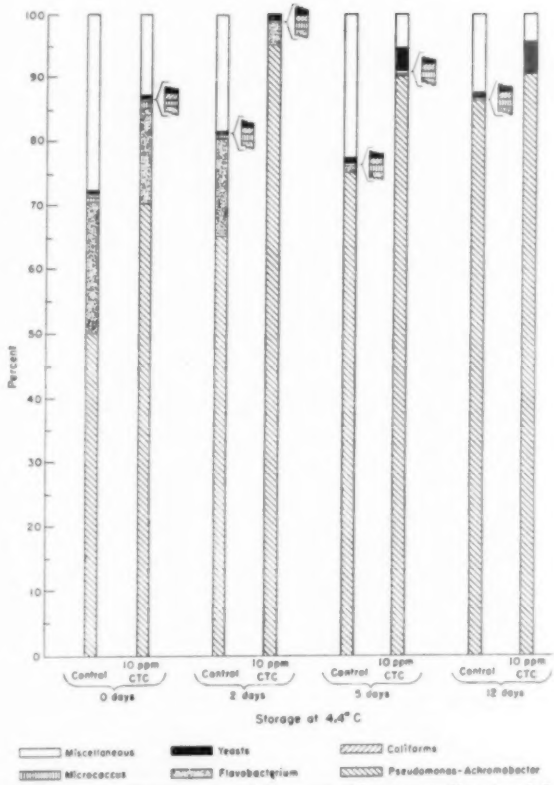

Figure 6. Comparison of flora of chlortetracycline treated birds and controls at various storage times.

chickens were stored at 4.4° C. Coliforms and staphylococci were present in very limited numbers and decreased on storage. No positive agglutination tests were obtained for *Salmonella*, either in control or treated birds. There was haphazard incidence of spore forming aerobes during the early days of storage but these organisms were of small consequence insofar as spoilage is concerned. Inasmuch as the population in the controls was more than 10 times as great as that on birds dunked in CTC solution, it is apparent that the miscellaneous microflora was greatly reduced.

Antibiotics such as aerosporin and neomycin which have been specifically recommended to destroy gram negative bacteria, were tested in combination with CTC to see if the antibacterial action of the two antibiotics would be complementary. When used individually at a level of 10 p.p.m., neither aerosporin or neomycin were very effective in reducing bacterial populations. Since the action of the two antibiotics was comparable, results for neomycin only are shown. As may be seen in Figures 7 and 8, the combined action of 10 p.p.m. of neomycin plus 10 p.p.m. CTC was more inhibitory than that due to CTC alone.

Numbers of yeasts growing on acidified malt agar are shown in Figures 5 and 9. It may be seen that the counts on the CTC treated chicken are much higher than are the controls. While the cause for this increased population is unknown, it might be assumed that the marked reduction in bacterial numbers (*i.e.*, 65

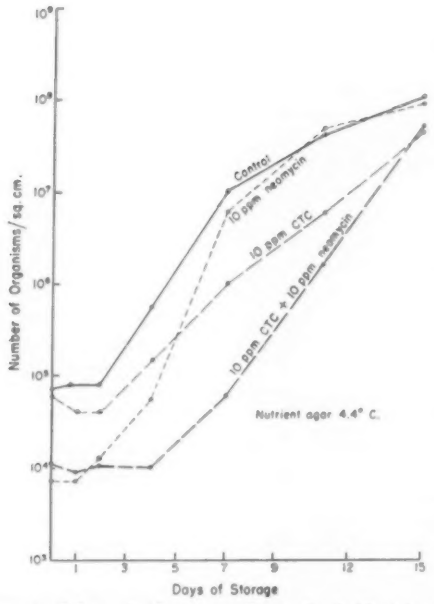

Figure 7. Effect of chlortetracycline and of chlortetracycline in combination with neomycin on bacterial populations.

thousand bacteria at 5 days vs. 1.5 million on controls) provides a more readily available substrate for development of yeasts. In Table 2 and Figure 6 it may be seen that with increased storage time, yeasts account for a larger share of the total population of treated birds while these microorganisms represent an insignificant portion of the microflora on control birds. It should be borne in mind that beginning with the seventh day of storage, untreated birds show signs of incipient spoilage while off-odor and slime are not in evidence on treated birds until the twelfth day.

Tests in malt agar with all of the antibiotics listed earlier showed that those that were least effective in delaying growth in nutrient agar also had the least influence on the size of yeast populations. On the other hand, as may be seen in Figure 9, of the antifungal agents, rimocidin and A-5288 (Lederle) were of value in inhibiting the development of yeasts. Inhibition by ascosin, and mycostatin was of a low order and when these two antifungal agents were used in combination with CTC, yeast counts exceeded those on birds receiving no treatment at all.

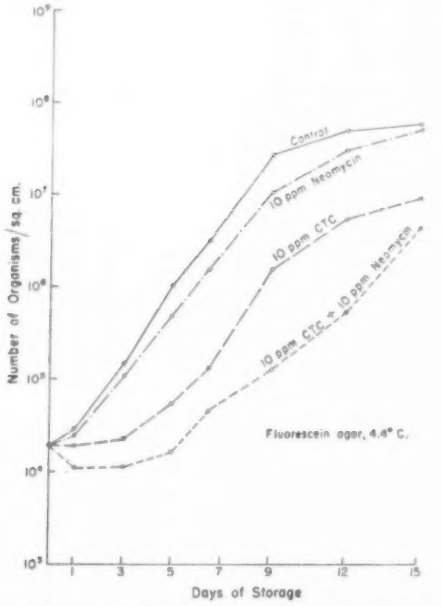

Figure 8. Comparison of the effects of neomycin, chlortetracycline, and chlortetracycline and neomycin on total numbers of organisms on fluorescein agar.

TABLE 2
Comparison of percentage of yeasts in birds treated with 10 p.p.m. and controls

Days	Control	10 p.p.m. CTC
0	0.6	0.9
1	.08	0.2
2	.08	0.3
5	.07	0.5
7	.01	1.7
12	.01	4.0
15	.02	12.0

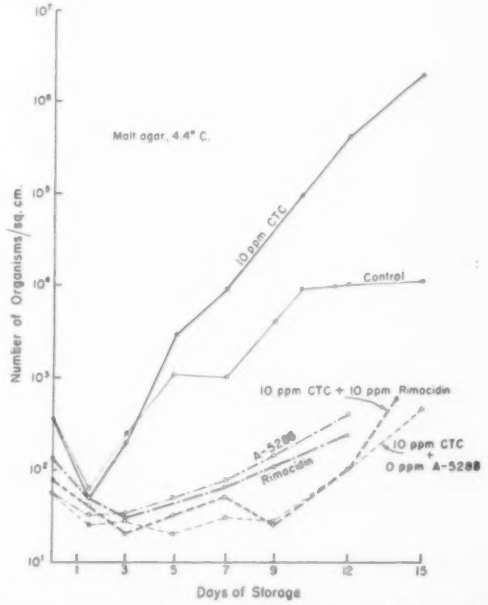

Figure 9. Comparison of yeast counts obtained on birds treated with CTC, A-5288 and rimocidin and combinations of CTC and A-5288 or rimocidin.

As may be seen in Figure 9, A-5288 and rimocidin when used coincidentally with CTC, effectively inhibited the development of yeast flora. During the first 15 days often the number of yeast colonies growing on the plates was so low or varied so greatly that the results had little meaning.

Figure 10 shows the effect on the total population of the concomitant use of an antifugal agent with an antibiotic. It is apparent that CTC when used alone delays off-odor and slime as well as it does when used in combination with either rimocidin or A-5288.

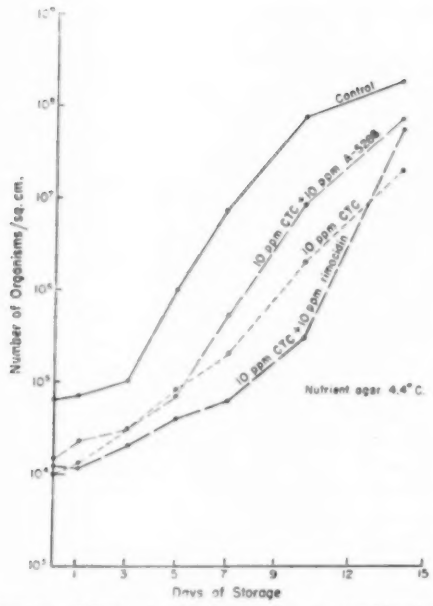
Control
10 ppm CTC + 10 ppm A-5288
10 ppm CTC
10 ppm CTC + 10 ppm rimocidin
Nutrient agar 4.4° C.
Number of Organisms/sq. cm.
Days of Storage

Figure 10. Effect of chlortetracycline in combination with A-5288 or rimocidin on the total flora.

SUMMARY

The effect of dipping eviscerated poultry in antibiotic and antifungal solutions for a period of two hours at 1.7° C. was tested. The agents used were: chlortetracycline, oxytetracycline, tetracycline, streptomycin, neomycin, aerosporin, rimocidin, A-5288 (Lederle), mycostatin, and ascosin.

At minimal concentrations (3 or 10 p.p.m.), chlortetracycline was the most effective antibiotic of the group for prolonging the storage life of birds stored at 4.4° C. Oxytetracycline was second in order of effectiveness and, at 30 p.p.m., these two tetracyclines were comparable. The other antibiotics and antifungals demonstrated little or no improvement over the controls for storage quality of the birds.

The concentration of CTC found on the skin of the birds rapidly decreased but persisted in low concentrations for 21 days or longer. The tissue was found to absorb as much as 7.8% water during the soaking period; however, no preferential absorption of antibiotics was observed.

During storage *Pseudomonas-Achromobacter* type organisms increased so that they comprised 90 to 95% of the population at the time that the birds developed off-odor and slime; however, in the CTC-treated birds, yeasts increased to a significant proportion of the population. The other types of organisms, coliforms, micrococci and chromogens, tended to decrease during storage.

The two antifungals, rimocidin and A-5288, appeared to be the most effective of the group in inhibiting yeasts. However, insofar as the total flora was concerned, the antifungals had only limited preservative effect.

The probability exists that a combination of antibiotics can be selected in such manner that their complementary action will markedly retard development of bacteria and fungi.

Acknowledgment

Appreciation is expressed to the Lederle Laboratories Division of the American Cyanamid Company, Pearl River, New York, for financial support, in part, of this research.

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Storage Stability of Canned Concentrated Tomato Juice[a]

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(Manuscript received June 14, 1956)

Since the first published report of the experimental production of concentrated tomato juice *(3)*, interest in this product has grown, and it is now being manufactured and market-tested commercially as a frozen and also as a conventionally canned product.

Concentrated tomato juice is marketed as a four-fold product and is thus cheaper to package by the difference in cost between a 6-ounce can for concentrate and a 24-ounce can for single-strength juice. It is also cheaper to handle and ship. Concentrated tomato juice has multiple consumer convenience; it can be used undiluted in place of paste or diluted as puree or juice. The reductions in bulk and shipping weight also offer advantage to the military forces.

Interest shown by the Quartermaster Corps in the

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storage stability of concentrated juices has stimulated studies on concentrated tomato products *(2, 3, 5, 6)*. In general these studies indicated a low degree of stability. However, the products investigated were usually of 25% or higher solids contents evaporated at relatively high temperatures and could not be considered representative of concentrated tomato juice manufactured under milder evaporation conditions.

Previous storage studies on concentrated tomato juice prepared in this laboratory *(3)* indicated that products concentrated at low temperatures had greater storage stability than has been indicated in the literature for commercial concentrated tomato products *(2, 5, 6)*. However, these former studies were based on concentrates made from commercially canned tomato juice. In order to evaluate the storage stability of concentrated tomato juice further, it seemed desirable to prepare samples under controlled conditions, with whole ripe tomatoes as starting material.

EXPERIMENTAL

Whole ripe Pearson tomatoes were crushed in a Fitzpatrick[c] comminutor with 0.25-inch screen openings. The macerate was pumped through a Votator[c] heat exchanger where the temperature was raised to 200° F. The total elapsed time was 10 seconds between crushing and emergence of the macerate at 200° F. from the heat exchanger. Preheated macerate was fed continuously to a paddle-type finisher having a 0.033-inch screen for extraction of the juice. The finished juice was accumulated in a holding tank maintained at 195° F. and blended with salt at the rate of 5 pounds per 100 gallons of juice.

A portion of the finished juice was filled hot into 6-ounce cans which were sealed, inverted, and air cooled. These samples constituted the control single-strength juice with which the stabilities of concentrated juices were compared.

The remaining juice was divided into 3 portions. These were separately evaporated to 21% solids determined by refractive index (RI), at temperatures of 105°, 150°, and 200° F., respectively. The evaporation times were maintained approximately the same (ca. 2 hours) for each temperature by varying the condenser temperature and degree of vacuum. The concentrates were then rapidly heated to 195° F. in a Heliflow[c] heat exchanger and filled hot into 6-ounce cans which were sealed, inverted, tapped down, and air cooled. The products thus obtained when reconstituted with 3 parts by volume of water made a single-strength juice of 6% solids (RI) containing 0.6% salt.

Samples of single-strength juice and the concentrated juices prepared at the 3 evaporation temperatures were placed in storage at 40°, 70°, and 100° F. and analyzed for changes in flavor, color, and ascorbic acid content after 2, 4, and 6 months.

Flavor changes between the juices and concentrates held at the same storage temperatures were determined by triangular taste tests previously described *(7)*. The panel was also asked to score a preference among the samples. It was assumed that a statistical preference would exist if, among the panel members who correctly identified the "odd" sample, the proportion who preferred one of the samples in the set over the other was significant at the 5% level or better. This situation never arose.

RESULTS

At the end of the 6-month storage period the single-strength juices and concentrates stored at the same temperatures were compared for visible color differences. Brown color development was measured by the alcohol extraction method previously employed in studies of browning in canned pasteurized dates *(4)*.

Ascorbic acid was determined on all samples after 2, 4, and 6 months by the A.O.A.C. method *(1)*. Determinations were made in duplicate on composites of 3 cans of each sample. Samples of both juice and concentrates were held at 100° F. beyond the 6-months' storage period and examined at intervals for development of "swells."

The organoleptic tests showed no statistically significant differences in flavor between the single-strength juices and concentrates after 2 and 4 months' storage at 40°, 70°, and 100° F. After 6 months' storage only small differences in flavor appeared, as shown in Table 1. However, no statistical preference existed for any sample.

Visual color comparisons in daylight and under tungsten illumination revealed no differences in color between the two lots of samples as a result of storage, as shown in Table 1. Determination of brown color by the alcohol-extraction method also failed to show any differences in browning between juices and concentrates stored at the same temperatures, as indicated in Table 1.

TABLE 1

Flavor and color differences between tomato juice and concentrates stored 6 months at 40°, 70°, and 100° F.

Sample	Evaporation temperature ° F.	Flavor difference and level of significance[1]	Statistical preference	Index of brown color[2]
Stored at 40° F.				
Juice		...	...	220
Concentrate	105	NS	...	218
Concentrate	150	NS	...	222
Concentrate	200	NS	...	226
Stored at 70° F.				
Juice		...	...	242
Concentrate	105	NS	...	240
Concentrate	150	NS	...	245
Concentrate	200	D-5%	None	247
Stored at 100° F.				
Juice		...	...	326
Concentrate	105	D-5%	None	329
Concentrate	150	D-1%	None	326
Concentrate	200	D-1%	None	326

[1] NS = not significantly different; D = different.
[2] Klett readings at 420 mμ.

Results of ascorbic acid analyses are shown in Table 2. The data show that at 40° F. there is little or no difference between the storage stability of ascorbic acid in juice as compared to concentrates. At 70° F. some differences in ascorbic acid retention appeared after 6 months. These differences are only slightly significant, but there is an indication that the storage stability of ascorbic acid may have decreased with increased evaporation temperature. The proportion of ascorbic acid retained after 6 months at 100° F. varied from 57 to 48%, respectively, in juice and juice concentrate evaporated at 105° F. to only 40% in concentrate evaporated at 200° F. The first swells were noted in samples of the concentrated juices after 19 months' storage at 100° F.

DISCUSSION

Results show that under storage conditions of 6 months at 40° and 70° F. little or no difference was found in flavor, color, or ascorbic acid stability of the tomato-juice concentrates as compared to the single-strength juice. After 6 months at 100° F., small unpolarized differences in flavor between juice and concentrates appeared. Varying differences in ascorbic acid stability also occurred.

There appears to be an effect of evaporation temperature on the future storage stability of tomato juice concentrates. This effect is indicated by the trend of relative ascorbic acid retentions in the different concentrates. Control of evaporation temperature and total exposure to heat during evaporation may be important in the manufacture of tomato-juice concentrate with good storage characteristics. Of course exposure to heat in subsequent operations is also a factor.

[c] Mention of specific products does not constitute endorsement by the Department of Agriculture over others of a similar nature not mentioned.

TABLE 2
Ascorbic acid retention in tomato juice and concentrates stored at 40°, 70°, and 100° F.

Sample	Evaporation temperature ° F.	Ascorbic acid retained (%) after:		
		2 months	4 months	6 months
Stored at 40° F.				
Juice		92	92	92
Concentrate	105	94	96	103
Concentrate	150	105	96	96
Concentrate	200	96	93	135
Stored at 70° F.				
Juice		95	....	86
Concentrate	105	97	....	84
Concentrate	150	93	....	83
Concentrate	200	95	....	80
Stored at 100° F.				
Juice		73	69	57
Concentrate	105	65	61	48
Concentrate	150	60	55	42
Concentrate	200	55	44	40

Apparently the discrepancies between previously reported low storage stabilities for concentrated tomato products *(2, 5, 6)* and the storage stability found in this study may originate from differences in processing methods. Where earlier studies included products of 24% or higher solids content an additional loss of storage stability is to be expected due to the effects of concentration on storage stability *(2)*.

CONCLUSION

Tomato juice concentrates of approximately 21% soluble solids content concentrated at low evaporation temperatures (less than 150° F.) possess characteristics of color and ascorbic acid stability which are not greatly different from those of single-strength tomato juice. Flavor of the tomato-juice concentrate evaporated at 105° F. was just significantly different from the control at the 5% level and flavor of the concentrates evaporated at 150° F. and 200° F. was highly significantly different from the control at the 1% level after storage for 6 months at 100° F.

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Stability of Frozen Concentrated Orange Juice. II. A Comparison of Several Methods of Heat Stabilizing Frozen Orange Concentrate[1]

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(Manuscript received June 5, 1956)

In a previous report *(5)*, the authors discussed the effect of heat treatment on enzyme inactivation and cloud stability of frozen concentrate made from Pineapple and Valencia oranges. This investigation was carried out with the use of a small tube turbulent flow pilot plant heat exchanger as the heating unit. Rouse and Atkins *(9, 10)* in studying heat inactivation of pectinesterase in citrus juices, used a small tube pasteurizer in combination with tubes held in a hot water bath. In later investigations, Atkins *et al. (2)* used a small tube unit for heating the juice to the desired temperature after which the juice was fed directly into a pilot plant evaporator. Atkins and Rouse *(1)* also used a third small tube unit varying the length of time required to bring the juice to temperature.

Bissett, *et al. (3)* in studying the effect of heat treatment on the storage of Valencia orange concentrates used an experimental tubular pasteurizer. Keller, *et al. (6)* used direct steam injection in studying stabilization of frozen citrus concentrates. DuBois and Murdock *(4)* utilized flash heating between stages of concentration at 18° Brix.

Commercial methods of stabilization currently used include direct steam injection, various plate type heat exchangers and large tube pasteurizers. These commercial units appear to have characteristics which differ from the experimental units. Because of this fact, it seemed desirable to compare several of the commercial methods with a small tube turbulent flow unit, representative of those units used experimentally. Such a comparison should make it easier to interpret the experimental results and to convert them to commercial use.

[1] A partial report on work conducted at the U. S. Citrus Products Station, Winter Haven, Florida, under a Memorandum of Understanding between the Continental Can Company, Inc., New York, New York, and the Southern Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

EXPERIMENTAL

All of the test variables used in this study were prepared and analyzed at the U. S. Citrus Products station in Winter Haven, Florida.

For the purposes of this study, lots of Hamlin, Pineapple, Seedling and Valencia fruit were placed at 40° F. until used. The oranges were washed and their juice extracted with a Rotary Juice Press.[b] Rag and seed were removed by passing the juice through a finisher equipped with an 0.033 inch screen. All the juice for a day's run was extracted in the early morning and pumped into a refrigerated tank where it was held at 40° F. until used.

The single strength juice was heat stabilized in either a small tube turbulent flow heat exchanger, a commercial plate type heat exchanger, or by direct steam injection at temperatures of 150° F., 160° F., 170° F., or 180° F. For the small tube variables, a Cherry-Burrell Viscolizer[b] was used to pump the juice through the small tube heat exchanger at the rate of 125 gallons per hour. This exchanger consisted of 33 feet of 5/16 inch, 20-gage stainless steel tubing encased in a hot water jacket. One-inch stainless steel tubing was used as a holding medium so that a 5-second holding time could be maintained. Temperatures of the juice were adjusted and maintained by automatic controls. The juice was cooled in an annular cooler to less than 90° F. in 3 seconds.

The commercial plate type unit was used only for the Valencia variables during the 1954 season. A variable speed 10BB Waukesha pump was adjusted to pump the juice through a specially designed Cherry-Burrell Super Plate-type Heater at 6 gallons per minute. The heating section was made up of 12 plates designed to heat the juice from 40° F. to 180° F. The first cooling section consisted of 12 plates utilizing well water to cool the juice from 180° to 75° F. A second cooling section, through which ice water was pumped, lowered the temperature of the juice to 40° F. It was calculated that with this equipment the juice was held at the desired temperature for three seconds.

Steam injection heating was accomplished by pumping the juice through a 1 inch-1½ inch Schutte and Koerting[b] stainless steel steam jet syphon at 6 gallons per minute with a 10BB Waukesha pump. A 5-second hold time was accomplished by using a specific length of one-inch stainless steel pipe between the steam injector and the two cooling sections of the Cherry-Burrell heat exchanger used to cool the juice.

TABLE 1
Analysis of juices used

Variety	Year	Initial Brix	Percent acid	pH	Percent oil content	Percent suspended solids
Hamlin	1955	11.0°	0.97	3.7	0.055	10.0
Pineapple	1955	11.4°	0.90	3.8	0.024	12.0
Seedling	1954	14.9°	1.16	3.6	0.066	15.8
	1955	12.8°	0.90	3.7	0.048	15.0
Valencia	1954	11.4°	0.85	3.6	0.066	15.8
	1955	11.7°	1.00	3.5	0.068	10.0

The heat treated juice was concentrated in a falling film pilot plant evaporator. Approximately 15 gallons of juice were concentrated to 2 to 3 gallons of 55° Brix concentrate. The evaporator was operated at 75° F. with temperatures of the heating medium at 106° to 120° F. The 55° Brix concentrate was cut back to 42° Brix with single strength unheated juice. The concentrate was packed at approximately 70° to 75° F. in 202 x 214 plain cans and frozen by placing the cans under an air blast in a 0° F. storage room.

The pectinesterase activity was determined by the method reported by Bissett, Veldhuis, and Rushing *(3)*.

The 42° Brix concentrates were tested for cloud stability by two methods. Samples of each variable were placed in 40° F. storage and stability was determined at regular intervals for at least 42 days. Cloud index was determined by a method described by Loeffler *(7)* on reconstituted concentrate using an Evelyn colorimeter equipped with a No. 720 filter. High cloud index (light transmission) readings indicated clarification or poor cloud stability. The cloud stability was also determined by placing a portion of the reconstituted 12° Brix juice in a test tube which then was stored at 40° F. After 24 hours the sample was visually graded as being either stable, partially separated or completely separated. By using both colorimeter and visual methods, it was possible to correlate the colorimeter readings with the actual cloud loss of the juice.

[b] Mention of trade products does not imply endorsement over similar products not mentioned.

RESULTS AND DISCUSSION

Results of experiments carried out on concentrate made from Seedling fruit during 1954 and 1955 are presented in Table 2 and Figures 1 and 2. The data in the table show that direct steam injection provided a greater degree of stability at the same treatment temperatures than did heat treatment by a small tube turbulent flow exchanger. The difference was more pronounced in 1954 than in 1955. The stability of the heat stabilized variables was better in 1954 than it was in 1955.

TABLE 2
The effect of heat treatment by small tube and direct steam injection on the cloud stability and pectinesterase activity of frozen orange concentrate made from Seedling fruit

Treatment temperature ° F.	Time (sec.)	Number of days completely stable at 40° F. storage		Stability of steam injection over small tube (days)
		Small tube	Steam injection	
1954				
150°	5	15 (45%)[1]	21 (22%)	6
160°	5	22 (15%)	34 (14%)	12
170°	5	21 (16%)	33 (17%)	12
180°	5	22 (15%)	42 (16%)	20+
1955				
150°	5	9 (47%)	10 (40%)	1
160°	5	12 (28%)	18 (25%)	6
170°	5	15 (20%)	21 (21%)	7
180°	5	22 (23%)	36 (18%)	14

Controls for both years remained stable for one day at 40° F.

[1] The figures in parentheses represent the percent of the original pectinesterase activity remaining in the heat stabilized 42° Brix concentrate.

As is shown in Figure 1, the small tube variable heat stabilized at 160° F. for 5 seconds remained stable for approximately 22 days. (For ease of presentation only the stability curves for 160° F. are shown.) The direct steam injection variable remained stable for 34 days; this was 12 days longer than when the small tube heat exchanger was used. There was very little difference in the percent pectinesterase activity remaining in the two variables; the small tube variable had 15% and the steam injection variable, 14%.

In 1955 (Figure 2) the small tube variable heat treated at 160° F. for 5 seconds remained stable for 12 days, while the steam injection variable remained stable for 18 days. Although the samples heat stabilized in 1954 showed greater differences between the two methods than did the samples treated in 1955, the steam injection method continued to provide greater stability than the small tube method.

Results of experiments carried out on concentrate made from Valencia fruit during 1954 and 1955 are presented in Table 3 and Figures 3 and 4.

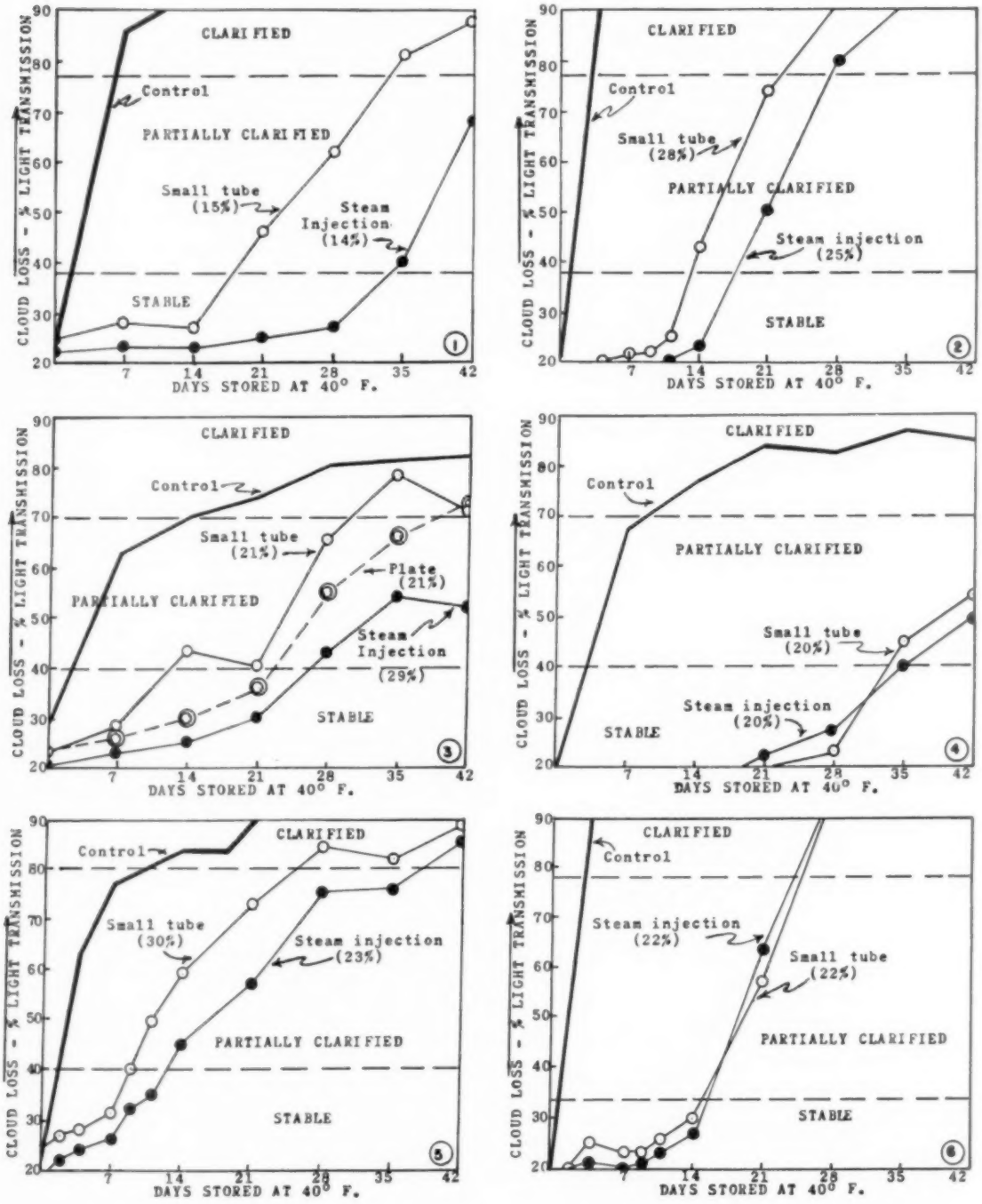

Figure 1. The effect of heat treatment at 160° F. on the cloud stability of concentrate made from Seedling oranges. 1954.
Figure 2. The effect of heat treatment at 160° F. on the cloud stability of concentrate made from Seedling oranges. 1955.
Figure 3. The effect of heat treatment at 160° F. on the cloud stability of concentrate made from Valencia oranges. 1954.
Figure 4. The effect of heat treatment at 160° F. on the cloud stability of concentrate made from Valencia oranges. 1955.
Figure 5. The effect of heat treatment at 160° F. on the cloud stability of concentrate made from Hamlin oranges. 1955.
Figure 6. The effect of heat treatment at 160° F. on the cloud stability of concentrate made from Pineapple oranges. 1955.

In 1954, three methods of heat treatment were used to stabilize concentrate made from Valencia fruit.

As is shown in Table 3, all three methods reduced the pectinesterase activity to approximately the same level in 1954. However, the steam injection variables remained stable for much longer periods at 40° F. than did either the small tube or plate type variables. The stability pattern appeared to be that the higher the temperature, the greater the difference between methods. This was not the case in 1955. The greater difference occurred at 150° F. At 160° F., 170° F., and 180° F., little difference between the small tube and steam injection methods was observed.

The curves shown in Figure 3 represent the stability of frozen orange concentrate made from Valencia fruit in 1954. This juice was heat stabilized at 160° F. for 5 seconds by small tube and plate type heat exchangers and by direct steam injection. Despite the fact that the

TABLE 3

The effect of heat treatment by several methods on the cloud stability and pectinesterase activity of frozen orange concentrate made from Valencia fruit

Treatment temperature °F.	Time (sec.)	Number of days completely stable at 40° F. storage						Stability of steam injection over small tube (days)
		Small tube		Steam injection		Plate[1]		
1954								
150°	5	4	(47%)[2]	9	(43%)	6	(54%)	5
160°	5	13	(21%)	27	(29%)	23	(21%)	14
170°	5	12	(15%)	35	(23%)	22	(17%)	23
180°	5	24	(12%)	42+	(19%)	24	(14%)	18+
1955								
150°	5	16	(36%)	27	(26%)			1
160°	5	34	(20%)	35	(20%)			11
170°	5	38	(17%)	35	(19%)			−3
180°	5	40	(20%)	42+	(19%)			2

Controls for both years remained stable for two days at 40° F.

[1] The average of three runs at each temperature.

[2] The figures in parentheses represent the percent of the original pectinesterase activity remaining in the heat stabilized 42° Brix concentrate.

amount of pectinesterase activity in the steam injection variable was the highest of the 3 units (29%), the juice remained stable for 27 days as compared to 23 days when heated by the plate type unit, and 13 days when heated by the small tube unit. The remaining pectinesterase activity after heating with either the small tube or plate type heat exchangers was 21.0%.

In 1955 (Figure 4), only the small tube unit and direct steam injection were studied. At 160° F. for 5 seconds little or no difference could be detected in the cloud stability of the two variables. Both were stable for longer periods of time at 40° F. than similar variables made from Valencia fruit in 1954.

Results of experiments carried out on concentrate made from Hamlin fruit during the 1955 season are presented in Table 4 and Figure 5.

Data in Table 4 show that heat treatment by direct steam injection did a more effective job of stabilizing concentrate made from Hamlin fruit than did the small tube unit. This was especially noticeable at 180° F. for 5 seconds where the steam injection method provided stability for at least 36 days longer at 40° F. than did the small tube method.

Figure 5 shows the stability curves for Hamlin concentrate heat-treated at 160° F. for 5 seconds by both small tube and direct steam injection. In this case, the steam injection variable remained stable for 12 days when stored at 40° F., whereas the small tube variable remained stable for approximately 9 days. The enzyme activity remaining in the steam injection variable was 23% of that found in the control while the small tube variable showed 30% activity remaining.

TABLE 4

The effect of heat treatment by small tube and direct steam injection on the cloud stability and pectinesterase activity of frozen orange concentrate made from Hamlin fruit

Treatment temperature °F.	Time (sec.)	Number of days completely stable at 40° F. storage				Stability of steam injection over small tube (days)
		Small tube		Steam injection		
1955						
150°	5	5	(53%)[1]	10	(44%)	5
160°	5	9	(30%)	12	(23%)	3
170°	5	8	(23%)	14	(19%)	6
180°	5	8	(23%)	42+	(16%)	36+

Controls remained stable two days at 40° F.

[1] Figures in parentheses represent the percent of the original pectinesterase activity remaining in the heat stabilized 42° Brix concentrate.

Results of experiments carried out on concentrate made from Pineapple fruit during the 1955 season are presented in Table 5 and in Figure 6.

Data in Table 5 show little difference in the cloud stability between the two methods of heating Pineapple frozen orange concentrate at treatment temperatures of 150° F., 160° F., and 170° F. However, at 180° F., the steam injection method provided stability for nine days longer than the small tube method.

Figure 6 shows the stability curves for Pineapple concentrate heat treated at 160° F. for 5 seconds by both small tube and direct steam injection. Results show that both variables remained stable for 15 days when stored at 40° F.

Samples of the orange concentrate variables packed in 1955 were tested for flavor differences by a group of 16 to 20 trained panel members. Each panel member was asked to rate 4 samples of concentrate consisting of a control, two steam injection variables and a small tube sample. Samples were graded on an hedonic preference rating scale of 1–9 where 5 indicated *neither like nor dislike*, where 1 indicated *dislike extremely*, and where 9 indicated *like extremely*.

A comparison of flavor ratings between unheated

TABLE 5

The effect of heat treatment by small tube and direct steam injection on the cloud stability and pectinesterase activity of frozen orange concentrate made from Pineapple fruit

Treatment temperature °F.	Time (sec.)	Number of days completely stable at 40° F. storage				Stability of steam injection over small tube (days)
		Small tube		Steam injection		
1955						
150°	5	9	(46%)[1]	9	(39%)	—
160°	5	15	(22%)	15	(22%)	—
170°	5	22	(19%)	23	(17%)	1
180°	5	24	(17%)	33	(16%)	9

Controls remained stable one day at 40° F.

[1] The figures in parentheses represent the percent of the original pectinesterase activity remaining in the heat stabilized 42° Brix concentrate.

controls and frozen orange concentrate heat stabilized by small tube or direct steam injection at various temperatures is presented in Table 6.

Results show no significant difference in flavor between any of the heat-treated variables and the unheated control. This was true for each temperature variable and for each of the varieties under study.

A review of all the data on enzyme inactivation showed that the direct steam injection method more effectively reduced the pectinesterase activity at 150° F. than did the small tube unit. (Approximately 35% activity remained after direct steam injection while 45% activity remained after heat treatment by the small tube unit). This difference was also apparent in the cloud stability data where there was an indication that the steam injection variables heat stabilized at 150° F. remained stable for approximately 5 days longer than the small tube variable. With treatment temperatures of 160° F., 170° F., and 180° F., little or no difference in pectinesterase activity could be found between the effectiveness of the two units. Both provided approximately the same degree of inactivation at the temperatures under study. It is interesting that this apparent correlation did not hold for the cloud stability data where the steam injection method became more effective as the temperature increased. For example, it was shown that the steam injection method provided stability for approximately 5 days longer than the small tube method at 150° F.; at 160° F. the difference was 6 days; at 170° F., the difference was 7 days; and at 180° F., the difference was 17 days; these differences despite the fact that there was little or no difference in enzyme activity at the higher temperatures.

TABLE 6

A comparison of flavor ratings between unheated controls and frozen orange concentrate heat stabilized by small tube or direct steam injection at various temperatures (1955 studies)

	Heat stabilization temperatures			
	150° F.	160° F.	170° F.	180° F.
Hamlin variety				
Control	6.3	6.2	5.5	5.9
Steam injection A[1]	6.3	6.1	5.5	5.6
Steam injection B[1]	6.1	6.2	5.8	5.8
Small tube	5.9	5.6	5.8	5.8
L.S.D. @ 5% level 0.6				
Pineapple variety				
Control	6.3	6.4	6.0	6.2
Steam injection A[1]	6.4	6.3	6.1	
Steam injection B[1]	6.2	6.2	6.1	6.1
Small tube	6.3	6.2	6.0	6.2
L.S.D. @ 5% level 0.5				
Seedling variety				
Control	6.4	6.2	6.2	6.2
Steam injection A[1]	6.3	6.2	6.2	6.4
Steam injection B[1]	6.4	6.2	6.3	6.4
Small tube	6.5	6.3	6.1	6.1
L.S.D. @ 5% level 0.5				
Valencia variety				
Control	6.3	6.5	6.3	6.5
Steam injection A[1]	6.3	6.5	6.3	6.4
Steam injection B[1]	6.2	6.6	6.2	6.4
Small tube	6.3	6.7	6.3	6.4
L.S.D. @ 5% level 0.5				

[1] Steam injection A and B represent duplicate runs made on single strength orange juice extracted from the same fruit.

The results show that the direct steam injection method of heat stabilization provided stability as good as and in most cases better than the small tube turbulent flow method. The greater effectiveness for cloud retention of the steam injection method over the other methods studied was not reflected in the pectinesterase activity of the variables under study. This would seem to suggest, as has been pointed out by McColloch *(8)*, that the mechanism of cloud retention or cloud loss is not as yet fully understood.

SUMMARY

An investigation was undertaken to study several methods of heat stabilization which have been used both experimentally and commercially to heat stabilize frozen orange concentrate. In all cases the direct steam injection method of heat treatment provided stability as good as, and in most cases, better than the small tube, turbulent flow method.

The greater effectiveness for cloud retention of the steam injection method of heat stabilization over other methods studied was not reflected in pectinesterase inactivation. With the exception of the 150° F. variable, the percent of enzyme activity remaining in the 42° Brix concentrate made from heat stabilized juice was approximately the same, regardless of the method used.

As the treatment temperature increased from 150° F. to 180° F., the degree of increased effectiveness of dirct steam injection over the small tube method became more pronounced.

Somewhat better cloud stability was obtained with a commercial plate type heat exchanger than with a small tube heat exchanger.

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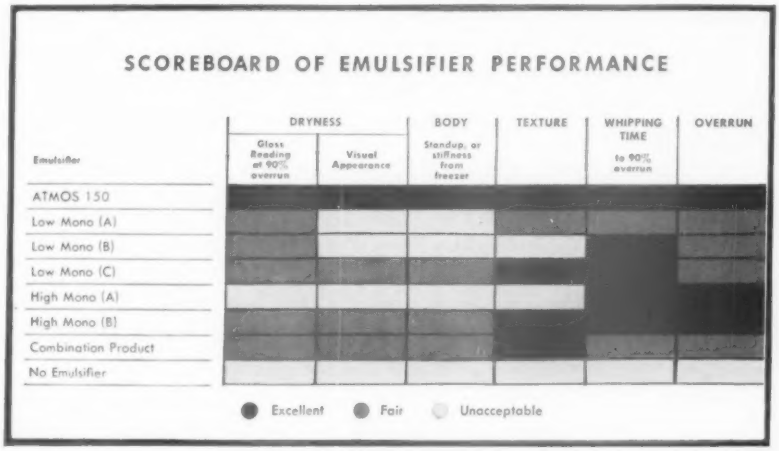

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Foxboro Magnetic Flow Meter. Accurately measures the flow of virtually any liquid except non-conductors like chocolate, fats and oils. Installs easily in the line like any equivalent length of pipe. No taps, seals, purges, meter runs, or straightening vanes required. Connects by 2-conductor cable to remote Dynalog Controller.

Foxboro Dynalog Recording Controller. Responds instantly to changes in volume flow, initiates fast, accurate valve action to hold pre-set rate. Troublefree, stepless measuring circuit has no slidewire — requires no standardizing or batteries, practically no maintenance. Control action can be air-operated or electric-operated.

Foxboro 2-way Saniflo Control Valve. A streamlined valve for liquids, suspensions, viscous or pulpy materials. Equally effective for throttling (proportional) or open-and-shut control. One-piece stem and plunger — no threads or crevices to harbor bacteria. Quick-disconnect clamp for easy cleaning. Can be replaced in control system by other type valve or a pump to meet process requirements.

FOXBORO
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SANITARY FLOW CONTROL

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

FOOD INDUSTRY TOPICS . . .

. . . by Norb Leinen

. . . in the public interest

The U. S. Atomic Energy Commission has approved negotiation of a contract for limited initial design and development work on a unique nuclear power system as a result of a joint proposal by the Chugach Electric Association of Anchorage, Alaska, and Nuclear Development Corporation of America, White Plains, N. Y. The proposal, made under the Power Demonstration Reactor Program, is for a power reactor of 10,000 electrical kilowatts capacity, using heavy water as moderator, liquid sodium as coolant, and slightly enriched uranium as fuel. The plant would be located at Anchorage. For the initial phase of the project, the AEC is asked to contribute a maximum of $2,225,000. Two of six other proposals for small-capacity nuclear power plants were approved previously as bases for contract negotiation; the remaining four proposals are still under consideration by AEC. Approved proposals are: (1) Rural Cooperative Power Assn., Elk River, Minn.—a closed-cycle boiler water reactor plant with electrical capacity of 22,000 kw; (2) Wolverine Electric Cooperative, Big Rapids, Mich.—an aqueous homogeneous reactor plant with electrical capacity of 5,000 to 10,000 kw.

◆ ◆ ◆

Low voltage or "soft" X-rays may prove to be the radiation of choice for a number of pharmaceutical sterilization operations, according to Dr. F. E. Porter of Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio. The statement was addressed to The Society for Industrial Microbiology, which met recently at the University of Connecticut under auspices of the American Institute of Biological Sciences. Dr. Porter's paper was entitled "The Use of Soft X-Rays in the Sterilization of Pharmaceuticals." Among products experimentally treated with soft X-rays are penicillin, vitamin B_{12}, and riboflavin. Each was sterilized without loss of potency. Battelle experimentation has been conducted with a unit composed of conventional transformers and a prototype X-ray tube with a novel beryllium window. The tube, built by Machlett Laboratories, Springdale, Conn., is designed for continuous operation on existing production lines and requires only one nontechnical operator. Because of efficient absorption of soft X-rays by water, shielding for such a unit can be provided relatively economically.

◆ ◆ ◆

Should food technologists jealously guard so-called "trade secrets" or exchange information on a freer basis for the good of the industry and society. This was the question posed by Leonard Stoloff, research director of Seaplant Chemical Corp., New Bedford, Mass., and chairman of the Symposium on Physical Functions of Hydrocolloids at the recent 130th National Meeting of ACS. He went on to say that men have always jealously guarded unique knowledge acquired by chance or diligent, intelligent search. The possessor of such knowledge, he stated, cannot be deprived of his position by force, but he can lose it either to a surfeit of his particular commodity or to a superior knowledge. Thus, traders in commodities based on skill or secret information tend to repress training and study in their fields. This is particularly true when the general advance of academic knowledge has not approached the areea involved and where the exercise of the skill or knowledge cannot be learned from observation or study of the product produced. Stoloff went on to explain that worthwhile technical meetings are produced when individuals realize that the tide of general knowledge has reached a point where they benefit more from their contribution than they lose from their revelation.

◆ ◆ ◆

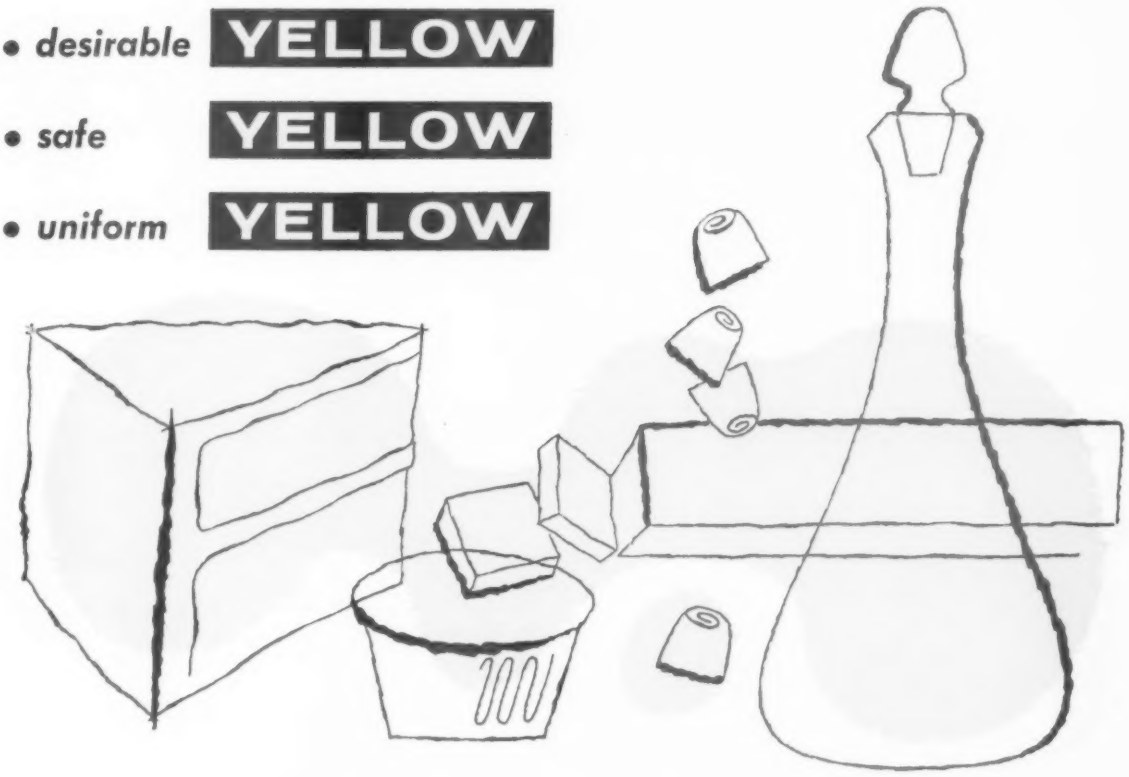
Many of the nation's civilian inventors have contributed their brain power toward solution of problems for the Armed Forces and have conceived ideas which have saved many lives and dollars. Over 200 successful inventions have been channeled through the National Inventors Council, which since 1940 has served as liaison agency between inventors and the military services. The Council publishes a cumulative list of technical problems turned over to it by the military agencies—ranging through the fields of plastics, chemistry, materials handling, and many others. An inventor who has a proposed solution to one of these problems can submit his idea to the Council which will evaluate it and, if it is practicable, present it to the proper military agency, eliminating red tape. To obtain a copy of the current "Technical Problems Affecting National Defense," write to National Inventors Council, U. S. Department of Commerce, Washington 25, D. C.

◆ ◆ ◆

The food industry has an opportunity this year to provide a 100% bonus with gifts to American medical schools through the National Fund for Medical Education, stated George H. Coppers, president of National Biscuit Company and chairman of the Food Division of the Fund's Committee of American Industry. The bonus is made possible, he explained, by an appropriation from the Ford Foundation which has set aside $10 million to be used over the next few years as a massive "pump-primer" to attract corporate support of medical education. For every dollar of unrestricted receipts this year up to last year's total, the Ford Foundation will contribute 70 cents. Everything above that will be matched dollar-for-dollar. The needs of the medical schools, Coppers stated, were never greater.

(Continued on page 42)

- *desirable* **YELLOW**
- *safe* **YELLOW**
- *uniform* **YELLOW**



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In a triumph of modern organic chemistry Roche scientists have produced beta carotene, one of Nature's complex substances. It is identical chemically and in biological activity with Nature's own product. Beta Carotene 'Roche' is a *natural* color. It is *naturally* safe! So efficient is Roche manufacturing that you are assured of . . .

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(Continued from page 40)

Although food the world over is selected, prepared, and its excellence judged by its color, very few scientific investigations have been devoted to determining the effect of appearance on food consumption, stated Dr. Dean Foster, director of laboratories, United States Testing Co., Hoboken, N. J., in a speech delivered at The Perkin Centennial in New York City on September 12, and entitled "Psychological Aspects of Food Colors from the Consumer's Standpoint." He explained his use of the word "psychological" by describing five areas of psychology: perception, motivation, emotion, learning, and thinking. Each, he stated, is a concern of the discussion insofar as it aids in the study of man's response to color. One of the tests showing an emotional response to color, reported by Dr. Foster, was a preference test in which panel members were served paired foods identical in every respect except for small amounts of special dyes. Results showed that, in every instance, the food most similar in color to the familiar or natural hue was strikingly preferred.

◆ ◆ ◆

Bethlehem Steel Company announces release of its newest 16 mm. sound motion picture, "Bright Steel," which describes the manufacture of quality tinplate and backplate and its use in food canning, bottle capping, and other industries. The 29-minute color film is available for showing on free loan in industrial plants to management groups, foremen's groups, and shop personnel. It also is available to technical and engineering societies and other adult groups, and to colleges and secondary schools. To arrange for a showing, send request at least one month in advance of planned play date to Modern Talking Picture Service, Inc., 3 E. 54th St., New York 22, N. Y.

◆ ◆ ◆

The story of what has been happening to the American market in recent years and its potential for the future is the subject of *Life* Magazine's new color motion picture, "Opportunities Unlimited." Produced by Transfilm, the film is 18 minutes in length, with more than half presented in cartoon animation and the remainder in live photography. It cites the increase in population as the most significant reason for the many opportunities now facing American business. Stressed in the film is the challenge which expanding markets and increased productivity present. "Opportunities Unlimited" will be shown to businessmen throughout the country by *Life* regional sales offices.

◆ ◆ ◆

Field salesmen for manufacturing companies increased their earnings by an average of 3½% last year, according to a new survey of sales compensation by American Management Assn., 1515 Broadway, New York 36, N. Y. The study analyzes compensation paid to more than 17,000 sales personnel in nearly 200 companies between spring 1955 and spring 1956. Positions included are those of sales trainees, three grades of salesmen, sales supervisors, and district and regional sales managers. Although total compensation of the 14,093 salesmen covered varies considerably, more than three-fourths of them earned between $5,000 and $15,000 last year. At or near the bottom of this range are salesmen in such categories as that of beginning salesman for a food company; the experienced salesman for a firm that manufactures diesel locomotives is an example of the type ordinarily found at the top. Like other surveys of the association's Executive Compensation Service, this one is designed to enable subscribing companies to evaluate their own policies in the light of current industrial practice.

◆ ◆ ◆

Chromatographic analyses of 91 samples of corn syrup and other cornstarch hydrolyzates by three laboratories give a more complete picture of the composition of these products than previously has been available. Listing eight components in place of the previous four, the analyses covered acid hydrolyzates over a D.E. range from 11.5 to 67.7 (D.E., or dextrose equivalent, is a measure of the reducing-sugar content calculated as dextrose and expressed as a percentage of the total dry substance). Samples from all American manufacturers were included. The analyses were made under direction of a special subcommittee of the Technical Advisory Committee of Corn Industries Research Foundation, Inc., 3 E. 45th St., New York 17, N. Y.

. . . *things new under the sun*

A completely new line of stereoscopic microscopes—the Cycloptic Series—is announced by American Optical, Instrument Division, Box A, Buffalo 15, N. Y. Greater comfort and ease of use as well as lower prices have been achieved by a radical new design whose basic component is the MAGNI-CHANGER, a numerically calibrated cylinder containing 16 achromatically corrected optical elements. Desired magnifications are simply "dialed-in" by rotation of the MAGNI-CHANGER; resultant magnifications range from 3.5 X to 80 X. All Cycloptic models are supplied with inclined, reversible, binocular bodies; standard apochromatic objective; wide-field eyepieces; and desired auxiliary lens attachments. Extremely long working distances ranging to 8" allow examination of extra large specimens. A wide variety of models is available for both laboratory and industrial use.

◆ ◆ ◆

A new, improved Flocron Electronic Liquid Dispenser, developed by Magnuson Engineers, Inc., will dispense brine, ascorbic acid, oils, or other liquids simultaneously from two or three heads into one can,

(Continued on page 45)

COULD
YOU
USE
ANOTHER
CUSTOMER ?

COULD
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CUSTOMER

Whether you're a

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canner . . .

ice cream manufacturer . . .

Take a look
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Sell her a Su
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using SUCAR
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BIG

when you add a **Sucar**

a look at this big customer. As one of about 30,000,000
eight in this country, she's trying to do something about her
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r a SUCARYL-*sweetened line*. There are several good reasons
should be SUCARYL. Number one, of course, SUCARYL has
lories. Number two: There's at least a 50-50 chance she's
SUCARYL right now in her home. And if she isn't, she's read
it in national ads. So, she's half-way to being sold the minute
es SUCARYL on the label.

customer

aryl® sweetened line

Take a lool
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Finally, SUC
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Think abou
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at: Chemica
Laboratori

Non-Calo

a look at this big customer. As one of about 30,000,000 weight in this country, she's trying to do something about her lem. She's watching her weight, and she's shopping carefully. *er a* SUCARYL-*sweetened line*. There are several good reasons it should be SUCARYL. Number one, of course, SUCARYL has alories. Number two: There's at least a 50-50 chance she's SUCARYL right now in her home. And if she isn't, she's read t it in national ads. So, she's half-way to being sold the minute ees SUCARYL on the label.

ly, SUCARYL hasn't that metallic taste common to other type aloric sweeteners. You can offer her a product every bit as and sweet as a sugar-sweetened product, *without* sugar's es. She'll buy, keep buying—and probably tell her friends it.

about it. Then give us a call. And if you'd like, we'll send free SUCARYL sample to experiment with. Just tell us whether refer SUCARYL Sodium or SUCARYL Calcium. You reach us hemical Sales Division, Abbott ratories, North Chicago, Ill.

Abbott

Sucaryl®

Caloric Sweetener — No Bitter Aftertaste

Whether you're a

bottler . . .

canner . . .

ice cream manufacturer . . .

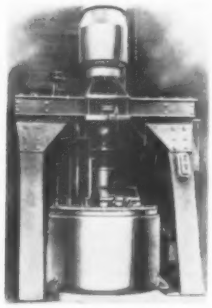
ne

(Continued from page 42)

or successively into two or three cans. Range of deposit sizes and speed is unusually wide due to options in nozzle size, hydrostatic head, and electronic timing. The Flocron is available on a lease basis only through The Morton Salt Co., 120 S. LaSalle St., Chicago 3, Ill.

◆ ◆ ◆

A completely automatic suspended centrifuge for the chemical, pharmaceutical, and food processing industries, which comes in sizes ranging from 20″ to 48″, is in production at The Fletcher Works. Operation can be either by hydraulic or electric drive motor. It reportedly is the first fully automatic equipment of its kind that can operate at a uniform speed, produce a uniform product, with each cycle yielding identical quality and quantity, yet eliminating human error. One operator can direct the activity of an entire bank of the centrifuges. Cycles can run through as low as 150 seconds, or as long as 32 hours (for penicillin). For information, write the firm c/o J. Robert Mendte, Inc., 317 S. 16th St., Philadelphia 2, Pa.



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New White Bear freezer paper coated with Tenite polyethylene makes an excellent wrap for frozen or refrigerator foods, sealing air out and moisture in. A single layer reportedly prevents freezer burn and preserves weight, flavor, and color of foods for long periods. The tough polyethylene coating serves as a barrier to liquids and moisture. It also has high resistance to tearing or puncturing, remains pliable at sub-freezing temperatures, resists greases and oils, is tasteless, odorless, non-toxic, and non-tacky. Foods wrapped in the paper may be sealed with water soluble tape or, if a tighter closure is desired, with an iron heated to 250°-300° F. Manufacturer is McLaurin-Angier Co., Homer, La. The Tenite polyethylene is supplied by Eastman Chemical Products, Inc., Kingsport, Tenn.

◆ ◆ ◆

Because more and more installations for bulk-materials handling by gravity discharge Tote Systems have shown a need for a dust-tight housing rather than a flexible spout attachment to the standard gravity-discharge Tote Tilt, Tote System Inc., Beatrice, Nebr., has incorporated such a housing into its standard line of system accessories. Such housings have been used in the past where management has installed gravity tilts atop surge hoppers.

◆ ◆ ◆

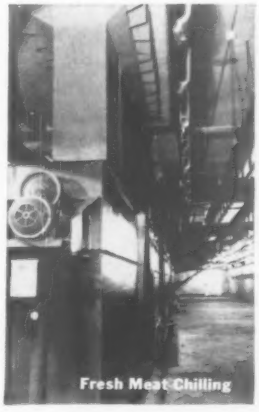
Removal of occluded oxygen by Fermcozyme (glucose oxidase-catalase) prevented development of oxidative rancidity in mayonnaise, and stabilized the initial color. After six months' storage, peroxide value on the control was 14.6 vs. 0.8 for the Fermozyme-treated mayonnaise. Noticeable fading of color in the

(Continued on page 54)

Ice Cream Hardening

NIAGARA "NO FROST"

25 Years' Successful Experience


Fresh Meat Chilling

Get faster temperature "pull-down"

Always clean freezing or storage rooms

Protect frozen food quality

Save Power...Reduce Costs

Citrus Concentrate Freezing and Storage

Write for Niagara Bulletin 105

NIAGARA BLOWER COMPANY

Dept. F.T., 405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities of U. S. and Canada

SELECTED ABSTRACTS . . .

Compiled by H. A. Campbell

ANALYTICAL METHODS

Alkaline solutions for pH control.

BATES, R. G., AND BOWER, V. E. (Natl. Bureau of Standards, Washington 25, D. C.). *Anal. Chem., 28* (7), 1322-4 (1956).

A series of alk. solns. useful for control of pH at any point between pH 7 and 13 can be prepd. by adding standard solns. of HCl or NaOH to portions of the following stock solns.: 0.1*M* tris (hydroxymethyl) aminomethane, 0.25*M* borax, 0.05*M* $NaHCO_3$, 0.05*M* Na_2HPO_4, and 0.2*M* $CaCl_2$. The compn. and buffer values of the solns. are given for intervals of 0.1 pH unit, and the diln. values and approx. temp. coeff. of pH are also indicated. The estd. accuracy is within ± 0.02 pH unit. The measured pH values agree well with those computed by the mass law.

Chromatographic separation and identification of furfurals from a mixture of the intermediates formed during the browning of the dried apricot.

WAHHAB, A. *Pakistan J. Sci. Research, 2*, 135-41 (1950); *Food Sci. Abstr., 28* (3), No. 1262 (1956).

It has been postulated that browning is due to the conversion of sugars and sugar acids to furfurals or similar compds., having carbonyl groups which condense with the N compds. or polymerize to form the brown material. Since it was observed that an aq. ext. of darkened dried apricots gave an absorption band at about 285 mμ, the sepn. and identification of the furfurals was investigated, by means of chromatography and spectrophotometry. From the ext. of darkened dried apricot, 15 carbonyl compds. were sepd. chromatographically. The 2,4-dinitrophenylhydrazones of these compds. were selected for study because of their color and high mol. wts. Furfural and hydroxymethyl furfural, the two important intermediates formed during the browning of dried apricots, were identified by their chromatographic behavior and the spectrophotometric curves. The observations confirm the presence of these compds., in addn. to those previously reported. The identification of methylfurfural was tentative, since there is so far no other conclusive evidence except the weak Maquene test. The work throws light on the mechanism of the browning reaction.

Process applications of analytical instruments.

SIMON, H. (Fluor Corp., Ltd.). *Instruments and Automation, 29* (6), 1141-5 (1956).

A resumé of the applications of analytical instruments (infrared, ultraviolet, mass spectra, refractometry, magnetic susceptibility, thermal conductivity) to process industries.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Determination and comparison of amino acid composition of yeast and distillers solubles.

SPANYER, J. W., AND THOMAS, A. T. (Brown-Forman Distillers Corp., Louisville, Ky.). *J. Agr. & Food Chem., 4* (7), 631-3 (1956).

Fifteen amino acids were estd. by paper chromatography in a strain of *Saccharomyces cerevisiae* and in distillers solubles. The materials and procedures used are given.

The physical chemistry of enzymes.

Discussions Faraday Soc. No. 20 (1955 publ. 1956).

The discussion was divided into 2 sections. I. Characterization and physical properties. II. Kinetics and mechanisms. Papers presented which are of special interest are: Transport processes and the heterogeneity of proteins. Certain physical properties of chymotrypsin and chymotrypsinogen using the depolarization of fluorescence technique. Mechanism of activation of trypsinogen and chymotrypsinogen. Activation and inactivation of milk xanthine oxidase by physicochemical means. The influence of fluctuations in protein charge and charge configuration on the rates of enzymatic reactions. Some kinetic and mechanistic aspects of hydrolytic enzyme action. Some chemical and kinetic studies of crystalline papain. The chemical kinetics of some reactions catalyzed by pancreatic carboxypeptidase. The chemical structure of the reactive group of esterases. The mechanism of reaction between esterases and phosphorus containing anti-esterases. Isotopic exchange criteria for enzyme mechanisms. The group-transfer activity of certain hydrolytic enzymes. Activation and inhibition of enzymes. Steps in the formation and decompn. of some enzyme-substrate complexes. Interaction of hydrogenase with hydrogen. The kinetics of hemoglobin and haem compounds as models for enzyme action. Intracellular reaction kinetics. On the interaction between coenzymes and enzymes. Calculation of the rate constants of the reaction between an enzyme and its substrate from the overall kinetics of the reaction catalyzed by the enzyme. Some applications of deuterium to the study of enzyme mechanisms.

Effects of bile acids on protein metabolism. V. Protein synthesis and decomposition. VI. Protein decomposition. VII. Effects of cathespin on protein decomposition.

NAKATA, S. *Hiroshima J. Med. Sci., 3*, 245-64* (1955); *Intern. Abstr. Biol. Sci., 4* (1), No. 233 (1956).

When various essential or non-essential amino acids or casein were added in excess to the diets of rats, these substances, as judged by the non-protein N [NPN] excretion in urine, did not accumulate in the body, but were rapidly excreted. When cholic or deoxycholic acid was also administered, some accumulation was observed, being more marked with non-essential than with essential amino acids. Administration of bile acids to starving rats reduced the amt. of NPN excreted in the urine. Bile acids accelerate protein synethesis and check protein decompn. When homogenates or cathepsin enzyme exts. of the livers of rats were incubated with gelatin, the amt. of NPN in the incubated soln. increased with time. Injection of cholic or deoxycholic acid, 10 mg. daily for 3 days before the removal of the livers, reduced the amt. of NPN produced, while cortisone, 3 mg. daily for 3 days, increased it. When homogenates or glycerol exts. of the livers of various animals were incubated with gelatin, the amt. of NPN produced by the action of cathepsin on protein increased with time, being most with the livers of cats, and least with those of pigs, rabbits, and fish.

The separation of phosphatides by paper chromatography.

AMELUNG, D., AND BÖHM, P. (Univ. Bonn.). *Hoppe-Seyler's Z. Physiol. Chem., 298*, 199-209 (1954); *Biol. Abstr., 30* (1), 547 (1956).

Lecithin, ethanolamine-cephalin and serine-cephalin are sepd. by a paper chromatographic method, using first acetone-MeOH (4:1) and then H_2O-satd. phenol as developing solvents (in the same direction). The various lipids are identified by color reactions (for amino-groups, phosphate, choline, and acetal). The method was used to demonstrate serine-contg. acetal phosphatides in brain, and the presence of an acetal-contg. fraction in beef heart lecithin.

BOTANY

The Mexican Candelilla plant and its wax.

HODGE, W. H., AND SINEATH, H. H. (U. S. D. A., Beltsville, Md.). *Econ. Botany, 10* (2), 134-54 (1956).

About eight million lbs. of this wax, obtained from wild plants in northern Mexico and adjacent parts of Texas, have been used annually in the U. S. in recent years—three million of them in the chewing-gum industry, the rest in the manuf. of coating and polishing preps.

The recognition, isolation, and partial identification of a new naturally occurring amino acid amide in plants.

POLLARD, J. K., AND STEWARD, F. C. (Cornell Univ., Ithaca, N. Y.). *Plant Physiol., 31* (suppl.), 9 (1956).

(Continued on page 48)

To obtain UNIFORM product quality

specify a Proctor DRYING RANGE

NEWEST PRE-FORMING TECHNIQUES
FASTER, MORE UNIFORM DRYING
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Yeast requires sensitive drying methods. This Proctor installation at National Yeast Company maintains the uniform quality, color, and viability of the yeast at considerably increased drying rates.

Uniform product quality can be obtained only through flexible, sensitive drying methods. Proctor equipment provides the construction features and controls necessary to achieve uniform drying. Many materials heretofore considered unsuitable for conveyor drying can now be handled with speed and efficiency by means of Proctor pre-forming techniques. And, as always, Proctor equipment carries performance guarantees based on wide experience and careful analysis of the requirements. Write for complete information. Ask for bulletin #410.

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Manufacturers of Industrial Drying Equipment and Textile Machinery

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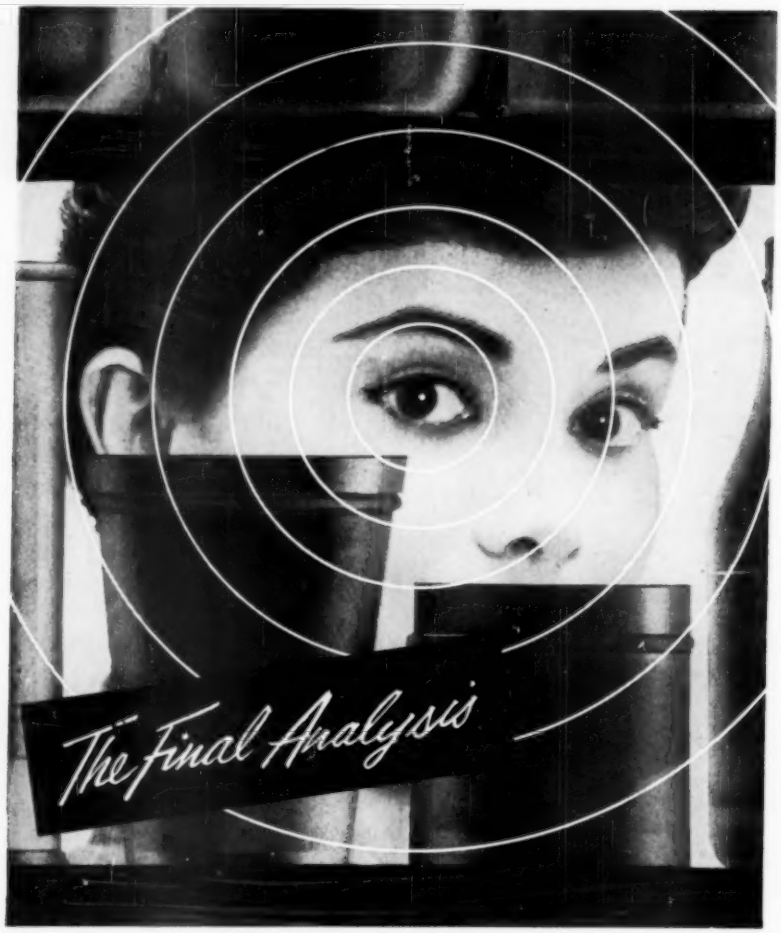

A look into the versatile abilities of Takamine Enzymes will help in the final analysis of your products at the market-place.

If you are plagued with processing or stability problems involving starches, pectins, proteins, glucose (browning reaction) or oxidative changes, Takamine Enzymes will speed operations, control viscosity, enhance flavor and taste and improve storage stability.

Takamine Enzymes serve you in *two ways* — they promote smooth processing operations *and* give your product a *selling personality*.

Send for our complete technical bulletins regarding your product or problem. Please address inquiries to our Technical Service Department.

Takamine Enzymes make it taste better, look better, sell better

DIASTASES
for liquefaction and hydrolysis of starch to produce soluble dextrins and sugars—also, to remove starch causing filtration problems and turbidity.

GLUCOSE-OXIDASE
to prevent browning due to glucose or oxygen and to increase shelf-life of food and beverage products.

PROTEINASES
for the modification and hydrolysis of proteins in food manufacturing and pharmaceutical operations.

PECTIC ENZYMES
for the hydrolysis of pectins in fruit and fruit juices to speed processing and to make fruit juices sparkling clear for consumer appeal.

TAKAMINE

TAKAMINE LABORATORY
DIVISION OF MILES LABORATORIES, INC.
CLIFTON • NEW JERSEY

(Continued from page 46)

A substance of empirical formula $C_{10}H_{16}N_2O_6$ has been isolated from two plants. It reacts with ninhydrin and on hydrolysis yields hydroxyglutamic acid and NH_3 in a 1:1 molar ratio. Like glutamine the substance loses ninhydrin reactivity, presumably due to pyrrolidone formation. It is presented to be hydroxyglutamine linked to an unidentified $C_5H_9O_2$ moiety.

MICROBIOLOGY

Yeast and other micro-organisms as food.

FALANGHE, H. *Rev. quim. ind., Rio de Janeiro, 24,* 24-7 (1955); *J. Sci. Food Agr., 7* (3), i-165 (1956).

Using molasses, fruit waste, sulfite-liquors and hydrolyzed wood as substrate it was shown, in various parts of the world, that microorganisms can be grown which can be used to supplement the diet and supply a number of nutrients, particularly essential amino-acids. The organisms used have been *Saccharomyces cerevisiae, Torulopsis utilis, Candida arborea, Oidium lactis, Aspergillus niger* and *Torula pulcherrima* and work has been done on a number of others. The prepn. of the cultures and the process of production of food products from them are outlined.

NUTRITION

Nutritive value of calcium-fortified milk substitute from groundnut.

MOORJANI, M. N., SUBRAMANIAN, N., AND SUBRAHMANYAN, V. *J. Sci. Ind. Research* (India) *14C,* 210-12 (1955); *Food Sci. Abstr., 28* (3), No. 1312 (1956).

Addition of Ca in a mixt. contg. dibasic Ca phosphate, CaCl, Na citrate, and phosphate buffer, pH 6.8, followed by passing the fortified "milk" through a colloid mill or homogenizer, gave a product in which Ca was stable to prolonged heating in amts. up to 100 mg. per ml. Given as a supplement to rice diet for rats, the fortified "milk" had a nutritive value of 80% that of reconstituted dried whole milk given similarly. The percentage retention of ingested Ca and P was 55.9 and 21.7, resp., compared with 63.9 and 31.2 for the diet with reconstituted dried whole milk.

Vitamin B_{12} and protein metabolism.

HENRY, K. M., AND KON, S. K. (Univ. of Reading, Engl.). *British J. Nutr., 10,* 39-50 (1956).

Evidence is presented to show that vitamin B_{12} is involved in the synthesis of Me groups, but does not play a part in transmethylation. Results also demonstrated that vitamin B_{12} did not specifically improve the utilization of flour, soya, or casein proteins.

Utilization of phosphorus from various phosphate supplements by chicks.

MOTZOK, I., ARTHUR, D., AND BRANION, H. D. (Ontario Agr. Coll., Guelph, Ontario, Canada). *Poultry Sci., 35* (3), 627-49 (1956).

Twenty-seven phosphate supplements, both chem. and com. grades, were tested as to availability in a series of expts. with chicks. In view of the differences obtained in a no. of these expts. between the growth response and the % bone ash, it is suggested that either the requirement of P for growth is different from that for bone calcification, or that the metabolism of P for these functions is different. It is suggested that caution should be exercised in the interpretation of a single expt., even with replicated groups, and in interpretation of data detailing with comparative availability of the P in various supplements.

Growth promoting activity of ash when fed in practical diets to chicks.

CAMP, A. A., REID, B. L., AND COUCH, J. R. (Texas Agr. and Mech. Coll. System, Texas). *Poultry Sci., 35* (3), 621-7 (1956).

The inorganic constituents obtained from fish solubles or distillers dried solubles by ashing in a muffle furnace at 600° C. produced a highly significant increase in growth of chicks on a practical diet. Evidence was also obtained which confirms earlier reports to the effect that fish solubles, dried whey and distillers dried solubles increase the growth of chicks when added to an all-vegetable protein diet. The combination of fish solubles and dried whey stimulated the growth of chicks to a significantly greater extent than did these supplements added singly.

Adenosine as growth factor for chicks fed purified diet.

BARNETT, B. D., LAPIDUS, M., BIRD, H. R., AND STRONG, F. M. (Univ. of Wisconsin). *Proc. Soc. Exptl. Biol. Med., 92* (2), 372-4 (1956).

In 5 expts. growth of chicks was increased by feeding adenosine at 150 or 300 mg./kg. of purified diet. Fish solubles at the rate of 3% of the diet gave a more pronounced response than did adenosine. Adenosine did not consistently elicit a response in the presence of either fish solubles or dried whey.

The niacin and tryptophan requirements of chicks.

PATTERSON, E. B., HUNT, J. R., VOHRA, P., BLAYLOCK, L. G., AND MCGINNIS, J. (State College of Washington, Pullman). *Poultry Sci., 35* (3), 499-504 (1956).

Approximately 13.0 to 15.0 mg. niacin per lb. of diet were required for optimal growth of chicks fed the basal diets which contained an av. of 0.14% tryptophan. The tryptophan requirement was not more than 0.14% in the presence of an adequate level of niacin and not more than 0.24% in the presence of a minimal amt. of niacin. However, tryptophan completely compensated for a partial niacin deficiency.

Fat studies in poultry. 5. The effect of dietary fat level on the choline requirement of the chick.

MARCH, B., AND BIELY, J. (Univ. of British Columbia, Vancouver, B. C., Canada). *Poultry Sci., 35* (3), 545-9 (1956).

It was concluded that a diet contg. 600 mg. of choline per lb. from natural ingredients supplies sufficient choline for growth of chicks if the diet is adequate in methionine. The choline requirement of the chick is increased when high levels of fat are added to a diet low in methionine. This increase in choline requirement, however, appears to be secondary to an increased need for methionine.

The effect of alkaline hydrolysis of maize on the availability of its nicotinic acid to the pig.

BRAUDE, R., KON, S. K., AND MITCHELL, K. G. (Univ. of Cambridge, Engl.). *British J. Nutr., 10*, 51-66 (1956).

Microbiological and paper chromatographic studies showed that corn, in common with other cereals, has much of its nicotinic acid in bound form which is unavailable to microorganisms, rats, and pigs. Hydrolysis with 0.5 *N* NaOH liberated the bound nicotinic acid. When hydrolyzed corn products were fed to niacin-deficient pigs, the animals recovered from the deficiency.

PHYSIOLOGY AND MEDICINE

Some experiences with plant physiology in medical research.

MACHT, D. I. (Labs. of Sinai Hosp., Baltimore). *Plant Physiol., 31* (suppl.), 19 (1956).

A new branch of biology called Phytopharmacology is described. Living plants may be more sensitive to some drugs than animals, and vice versa. The blood and secretions of menstruating women and persons suffering from grave skin diseases (e.g. leprosy) markedly inhibited the growth of lupine seedlings. Of greater importance is the effect of the blood and secretions of psychotic and cancer patients on the growth of the seedlings.

Two dimensional electrophoresis of serum proteins.

SMITHIES, O. (Connaught Med. Research Labs., Engl.). *Nature, 177*, 1033 (1956).

Normal human serum has been resolved by a two-dimensional electrophoretic system into at least 15 components. The first electrophoresis is carried out on filter paper while the second at right-angles to the first is accomplished on a starch gel so that resolution by mol. sizes is superimposed on resolution by free soln. mobilities.

FOOD AND FOOD TECHNOLOGY

BAKING AND BAKERY PRODUCTS

Characteristics of shortened cake baked in a fast and in a slow-baking pan at different oven temperatures.

CHARLEY, H. (Oregon State Coll., Corvallis). *Food Research, 21*, 302-5 (1956).

Oven temp. adjustments failed to eliminate differences in shortened cakes caused by the use of the fast-baking japanned iron pan and the slow-baking tinned iron pan.

CEREALS AND GRAINS

The penetration of urea and orthophosphate into the wheat kernel.

FERRIGAN, M., NORRIS, C., BOYER, P. D., AND GEDDES, W. F. (Univ. of Minnesota, St. Paul). *Cereal Chem., 33* (4), 240-53 (1956).

Wheat kernels infiltrated under various conditions with rat urine contg. C^{14} as urea or P^{32} as inorg. phosphate and, in some cases, with indigo carmine were embedded in celloidin. After hardening, histological sections were cut and exposed to autoradiographic plates by direct contact. Penetration of P^{32} and C^{14} into sound kernels, as well as into kernels with hairline cracks in the surface, occurred particularly around the germ and along the crease. Washing the infiltrated kernels reduced the radioactivity on the surface but did not affect the contamination in the interior. Urea and radioactivity detns. showed that while bran presents a considerable barrier to their entry, both constituents penetrated the endosperm at different rates and contaminated the flour. Neither dry-scouring the kernels nor washing them prior to milling had any appreciable influence on the total radioactivity or urea content of the flour fractions. The degree of penetration observed cannot be interpreted as a measure of the extent to which flour might be contaminated in com. milling practice.

Collection, preservation and utilization of indigenous strains of maize.

CLARK, J. A. (Natl. Academy of Science—Natl. Research Council, Washington, D. C.). *Econ. Botany, 10* (2), 194-200 (1956).

The seed of more than 12,000 variations of Indian corn have been collected from many areas in the Western Hemisphere, and are preserved at regional centers to provide genetic factors in the future breeding of agronomically improved, disease-resistant and higher yielding varieties.

COCOA AND COCOA PRODUCTS

Viscosity in the chocolate industry.

KLEINERT, J. (Lindt & Sprungli, A. G., Switzerland). *Mfg. Confectioner, 34* (12), 19 (1954); *Chem. Abstr., 50*, 8936h (1956).

Chocolate is a non-Newtonian substance, and definition of the flow properties of a chocolate requires viscosity measurements at two or more shear rates. These may be plotted as a rheogram. Rheograms are detd. for two samples with the Epprecht multispeed rota-

Chemists! Technologists!

Test Your Know-how

How many uses for

Sta-Sol®

Lecithin Concentrate can you name?

Here are just a few applications for dozens of products.

Whether as an emulsifier, antioxidant, penetrant, or wetting agent Staley's Sta-Sol Lecithin concentrate has already proved its versatility in dozens of applications in a variety of products. And new uses are continuously being uncovered. A look at the partial listing below will give an idea of Sta-Sol's wide utility range.

Leather Processing—penetrating and softening agent.
Paints—retards settling and hardening of pigments—prevents "flooding" and streaking.
Pharmaceuticals—antioxidant for Vitamin A.
Bakery Goods—emulsifier—antioxidant—softens texture—reduces stickiness of doughs—prolongs shelf life—improves fat distribution.
Candy & Chocolate Coatings—reduces viscosity, increases coating capacity, less stickiness, retains moisture, lowers surface tension, improves texture and appearance.
Printing Inks—reduces grinding time, promotes better wetting and dispersion of pigments.
Shaving Creams—increases wetting power of lather, makes beard softer, gives smoother more "painless" shave.
Skin Lotions, Cosmetics, Beauty Soaps—softens and soothes skin, reduces irritation, increases cleansing power, stabilizes and improves lather.
Gravies-Sauces—prevents fat separation.
Peanut Butter—antioxidant—stabilizes flavor.

Can you add other uses to this list?
New product applications for Sta-Sol are being added all the time. Can you think of other uses? Perhaps your products should be added to this list. If you're in need of a more efficient, more economical emulsifier antioxidant, penetrant or wetting agent—get all the facts about Sta-Sol. See your Staley representative or write today for complete information. Learn how Sta-Sol can help you improve the quality of your products.

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Decatur, Illinois

Staley's

tional viscometer, whose construction and operation is described. Readings with this instrument were in good agreement with those obtained for the same sample from the Ferrenti multispeed rotational viscometer, except for the yield point.

COFFEE AND TEA

Designing spray dryers for instant coffee.

HEYMAN, W. A. (Foster D Snell, Inc.). *Coffee and Tea Ind., 79* (7), 19 (1956).

Second in a series of articles on the development of sol. coffee in various countries around the world as seen by Dr. Heyman. Dr. Heyman discusses briefly some of the engineering details which enter into the building of a spray dryer for sol. coffee.

CONFECTIONS AND CONFECTIONERY PRODUCTS

Chemical caramelization.

RAMSEY, R. J. (Ramsey Labs., Inc., Cleveland, Ohio). *Mfg. Confectioner, 36* (7), 27-9 (1956).

The production of caramel, butterscotch, molasses, etc., and the discoloration of sweetened dairy products is not only the result of the caramelization of the sugars in the presence of heat and acids. This study indicates that the sugar-amino acid condensation is the most important reaction. The rate of this condensation is influenced by pH, temp. and type of sugar present.

FATS AND OILS

The chromatographic separation of fatty acids and their derivatives.

WHALLEY, G. R. *Soap, Perfumery & Cosmetics, 29* (7), 783-9 (1956).

A review is given of some of the principles and methods employed in the chromatographic sepn. of the fatty acids. In addn. each method is discussed.

FRUIT, FRUIT JUICES AND VEGETABLES

Polyphenolic compounds of the persimmon fruit.

SIEGLMAN, H. W., AND CRAFT, C. C. (U. S. Dept. Agr., Beltsville, Md.). *Plant Physiol., 31* (suppl.) 38 (1956).

Isoquercitrin, hyperin, astragalin, trifolins, gallic acid, methyl gallate, scopoletin and a leucoanthocyanin fraction were found in ripe and unripe fruits of persimmon. The latter appears responsible for the astringency of the fruit.

A new sulfur amino acid in beans.

ZACHARIUS, R. M., THOMPSON, J. F., AND MORRIS, C. J. (Eastern Regional Research Lab., Philadelphia 18, Pa.). *Plant Physiol., 31* (suppl.) 44 (1956).

A new sulfur-amino acid has been isolated from beans and identified as S-methylcysteine.

MEAT AND FISH

Some applications of paper chromatography to the examination of meat extract.

WOOD, W. T. (Bovril Ltd., London, England). *J. Sci. Food Agr., 7* (3), 196-200 (1956).

Meat ext. was investigated by paper chromatography. Methods of removing inorg. salts and protein are discussed. The use of a wide range of color reagents has made it possible to show up different classes of compds. The method is rapid and simple and can be applied to any complex mixt. of a similar nature. A list of the substances detected is given and comparison made with previous analyses.

MILK AND MILK PRODUCTS

Contributions of industrial research in dairy manufacturing.

JOHNSON, A. H. (Natl. Dairy Research Labs., Inc., Oakdale, Long Island, N. Y.). *J. Dairy Sci., 39* (6), 804-11 (1956).

Developments and investigations on fluid milk, butter evapd. milk, dry milk, cheese and ice cream industries are discussed.

POTATOES

Influence of gamma irradiation of potato tubers on the rate of respiration.

GUSTAFSON, F. F., BROWNELL, L. E., AND MARTENS, R. A. (Univ. Michigan, Ann Arbor). *Plant Physiol., 31* (suppl.), 11-12 (1956).

Irradiated potato tubers, until the 13th week, respire at a more rapid rate than controls, and then exhibit a decrease in rate of respiration for those tubers receiving up to 25 kilorep. Tubers receiving a higher dosage continue the increased rate of respiration. Twelve hours after irradiation, there is increased O_2 consumption, which may continue for 14 weeks.

SUGARS AND STARCHES

A study of d-glucose polymerization.

DURAND, H. W. (Univ. of Pittsburgh). *Dissertation Abstr., 16*, 1064-5 (1956).

Crude polymers of α-D-glucose catalyzed by the action of metaboric acid were purified and subjected to various physicochemical measurements. Results indicated the polymers to be built up of many (at least 6-17) anhydro-D-glucopyranose units largely terminating in a D-glucosan residue.

Waxy starches properties and applications.

EVANS, J. W. (Am. Maize Product Co., Roby, Ind.). *Can. Food Ind., 27* (7), 31-5 (1956).

Waxy starch is a carbohydrate synthesized by combination or polymerization of dextrose. Raw or granular waxy starches are insol. in H_2O, but if an aq. suspension is heated beyond a certain crit. temp., the granules commence to swell. Waxy starch granules swell more

(Continued on page 52)

EXPLORING NEW HORIZONS WITH

FROEDTERT

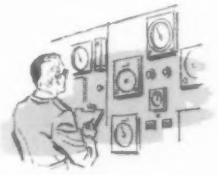
Where research is unlocking the secrets of barley malt

* FOR FOOD
* FOR BEVERAGES
* FOR INDUSTRIAL USE
* FOR ANIMAL FEED

Why Fro-Malt becomes new brand name for world's best-selling malt Froedtert is re-acquainting the general public with the health and energy-building benefits of barley malt—wherever it's used. To accomplish this, the world's largest maltster has (1) given its product the name Fro-Malt, (2) launched a series of *Saturday Evening Post* advertisements. Naturally, this program will aid promotion of products now containing Fro-Malt . . . lay groundwork for introduction of new products that will contain Fro-Malt.

If barley varies, how uniform the malt? Froedtert processing methods and quality controls have been developed to the point where adjustments can be made to compensate for almost any seasonal or local variations in the barley crop. Coupled with Froedtert's tremendous handling, storage and production capacity (8 plants), this means Froedtert customers are assured of unvarying uniformity.

Malt is one of nature's most wholesome foods — Even before planting, special barley is earmarked for malting. And, at Froedtert, premium barley is handled with extreme care. In storage and handling, elaborate safeguards are employed. Then, prior to processing, barley is mechanically cleaned, thoroughly washed. The malting process itself, which involves heat, is a purifying process.



Huge control panel acts as nerve center in new pilot malting facilities — Embodying the most advanced equipment, Froedtert's new pilot malting lab utilizes a 13-ft. control panel. With it, technicians maintain precise temperatures, exact moisture content and instantaneous control of operating procedures. This finite control, plus ability to duplicate exact sets of variables, allows Froedtert to reach previously impossible high levels of accuracy, uniformity and reliability.

Fro-Malt is available in many forms — for flavoring . . . coloring . . . to promote enzymatic action or add food value . . . and in some cases for use as a preservative. Contact Froedtert now to see how malt may be able to improve your formulation or processing.

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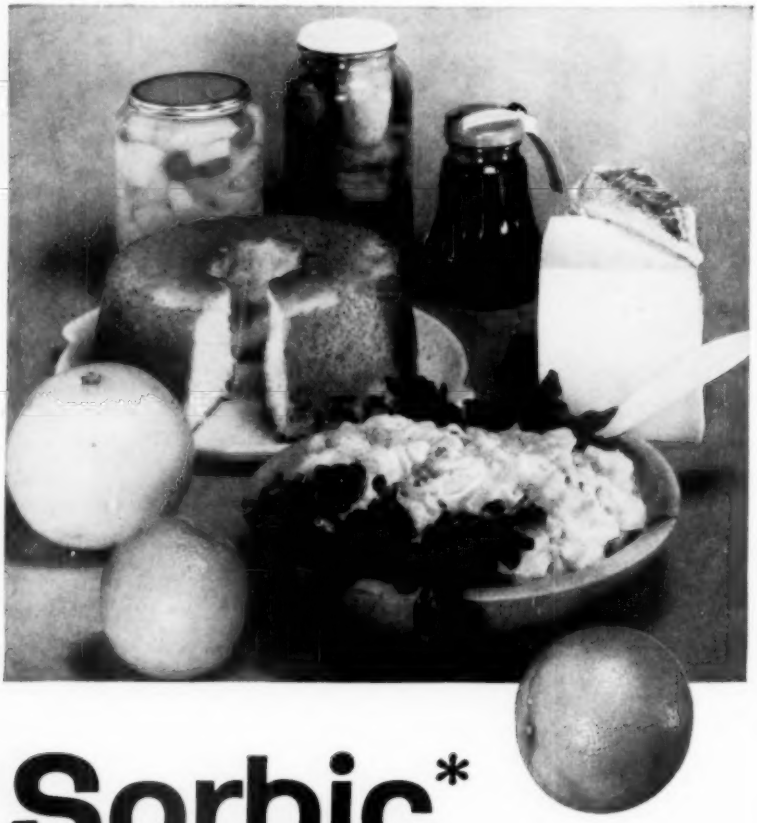

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(Continued from page 50)

rapidly than regular starch granules. Waxy starch (Amioca) pastes are clear, fluid, cohesive and stabilize other starches by reducing their tendency to gel. Amioca is used as one of the starch components in pudding mixes, salad dressings and canned foods.

The effect of irradiation on starch grains.

ROBERTS, E. A. (Massachusetts Inst. of Technol., Cambridge). *Plant Physiol., 31*, suppl. 11 (1956).

High energy-cathode rays convert some of the starch to dextrin, glucose, and fructose. The threshold value for the irradiation effect producing a chem. change upon the av. potato starch grain appears to be 5 x 10^6 rep. In the cold sterilization of foods the starch content is physically and chemically unchanged up to a dose of 4-5 x 10^6 rep.

STATISTICS

Factor analysis as a technique for examining complex data on foodstuffs.

HARPER, R. (Univ. of Leeds, Engl.). *Appl. Statistics, 5* (1), 32-48 (1956).

A technique for relating objective and subjective tests on foodstuffs is illustrated. A critical summary of the advantages and disadvantages of factor analysis is given.

PATENTS

Product derived from dried brewer's grains.

SIEFKER, J. A., GROVES, W., AND BRASCH, J. F. Assignor to Anheuser-Busch, Inc. 2,754,211, July 10, 1956.

A finely divided low fiber high protein content food supplement suitable for use in human nutrition derived from dried brewers' grains comprising at least 45% protein, approx. 8-10% fat, with an approx. biol. value of 82-93% and having a fineness of the order of 100 mesh and which is substantially free of starch.

Agents for preventing loss of gloss in candy coatings.

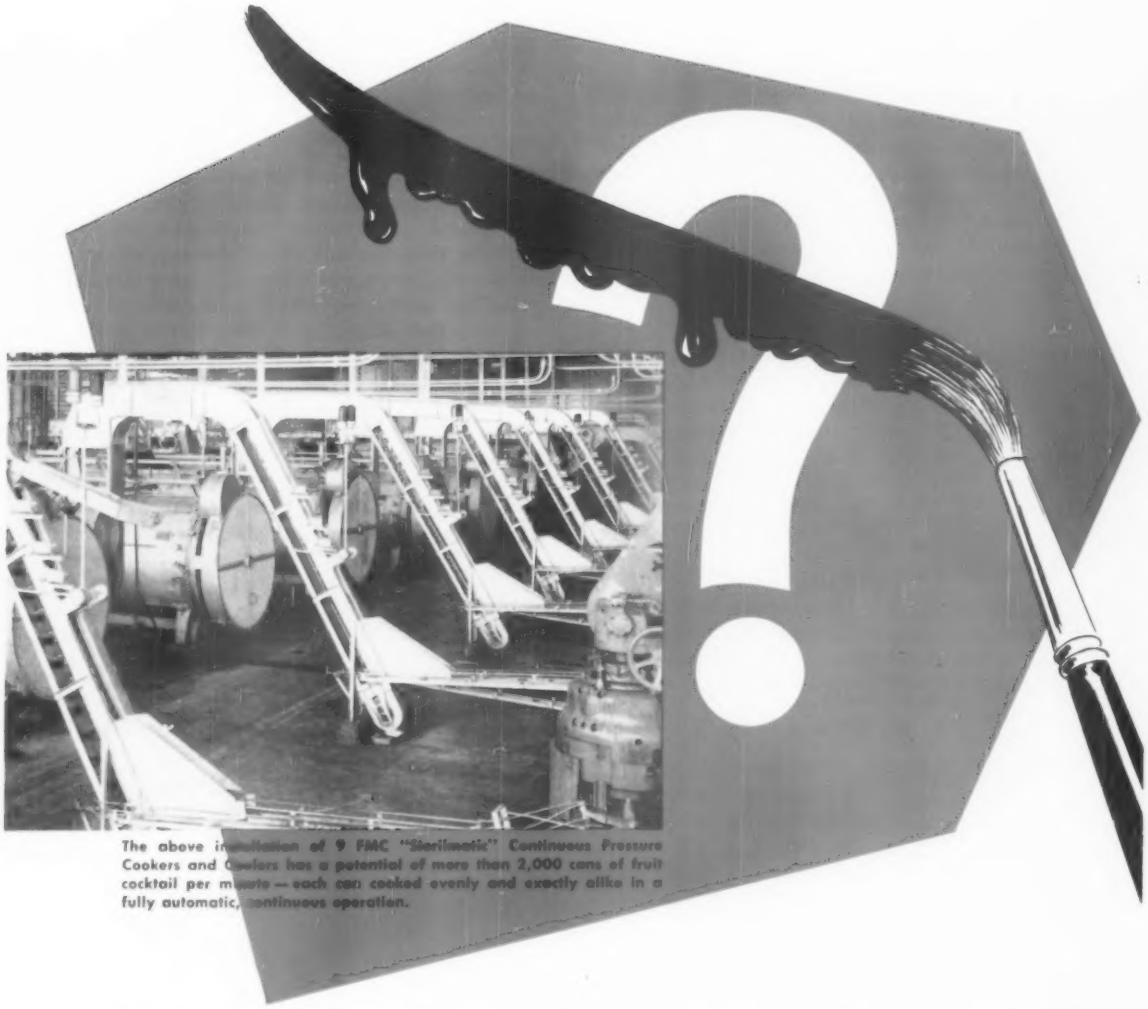
CROSS, S. T. Assignor to Atlas Powder Co. Can. 527,430, July 10, 1956.

A sugar-fat bon-bon coating in which the wt. ratio of fat to sugar lies between the inclusive limits of 80/20 and 25/75 inhibited against dulling by the incorporation of a mixt. comprising a partial ester of a higher fatty acid and a polyoxyethylene deriv. of a partial ester of a higher fatty acid.

Recovery of animal fat.

Brit. 748,814, May 9, 1956.

Fat is recovered from animal fat-contg. portions by sepg. these portions and hashing them while still contg. the natural animal heat and then subjecting them to high frequency vibrations to crack the cellular envelopes contg. the fat globules, the temp. during this step being controlled so as to maintain the released fat substantially in liquid form and below the coagulation point of the proteins therein.



The above installation of 9 FMC "Sterilmatic" Continuous Pressure Cookers and Coolers has a potential of more than 2,000 cans of fruit cocktail per minute — each can cooked evenly and exactly alike in a fully automatic, continuous operation.

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The "Sterilmatic"* in-can method of processing gives canners everything they need to maintain highest uniformity and quality standards with dependable regularity.

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(Continued from page 45)

control occurred after only four months, whereas the Fermozyme-treated sample retained initial color throughout the experimental period. Rancidity was detectible organoleptically in the control after three months; the Fermozyme-treated material showed no detectible rancidity even after six months. The experiment reported was run by a commercial processor. Write Fermo Chemicals, Inc., 4941 S. Racine, Chicago 9, Ill.

◆ ◆ ◆

A versatile, low-price, pocket-size pH meter for acidity and alkalinity measurements that is accurate, dependable, easy to operate, and uses a combination electrode is in production by Scientific Instruments Division, Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif. Range is from 2 to 12 pH. The single electrode combines both the reference and glass electrodes. The unit also has a "memory" dial for use in standardizing. It operates from simple, inexpensive batteries like those used in flashlights.

◆ ◆ ◆

Commercial availability of a standard sanitary bulk material elevating conveyor, known as Model No. 3 "BUCK-EL," is announced by The Bucket Elevator Co., 360 Springfield Ave., Summit, N. J. Of original design for the chemical, food and pharmaceutical industries, the "BUCK-EL" is manufactured with sanitary components and is easily disassembled for complete cleaning. Materials of construction include stainless steel casing and buckets, stainless steel shafts with vinyl covered pulleys, and food grade neoprene belting and gasketing. For less critical service, the unit is available in carbon steel with either chain- or belt-mounted buckets.

◆ ◆ ◆

One of the most revolutionary methods of can delivery—**a jumble system using a trailer as the delivery package**—has been announced by American Can Co. A fleet of eight specially engineered trailers, each holding some 130,000 jumbled six-ounce cans, is in service between Canco's Plymouth, Fla., plant and Minute Maid plants at Plymouth and Leesburg. B. M. Middlebrooks, director of concentrate manufacture at Minute Maid, reports that the new system has resulted in substantial savings in processing costs because of uniformity of flow and improved average rates of production at the closing machine. In the jumble trailer method, the cans are automatically transferred from the trailer to an unscrambler feeding the filling machines. The method has application where conditions are similar to those at Minute Maid. These conditions are: (1) large volume of a single size or label, within certain size limitations; (2) continuous line operation at the can plant, enabling direct loading of trailers; (3) a profitable delivery cost picture; and (4) a reasonable trucking distance—up to 50 miles in open country.

◆ ◆ ◆

Through addition of both nonionic and anionic wetting agents, MC-3, Pennsalt's soapless dairy washing powder designed for use in hard water areas, now has greater penetration powers and longer lasting suds for thorough and rapid cleaning action. In addition, the product is completely dust free for easier handling. Improved MC-3, manufactured by Pennsylvania Salt Mfg. Co., 3 Penn Center Plaza, Philadelphia 2, Pa., is available in water-resistant 5-lb. cans, packed 12 to the case, and in 25-, 125-, and 350-lb. full-opening type drums, at no price increase.

◆ ◆ ◆

A complete new line of paper towels, designed to fit all three of the towel dispensers commonly found in company washrooms today, has been placed on the market by Scott Paper Co., Chester, Pa. The famous ScotTissue towel, measuring $10\frac{7}{16}$" by 14", is now joined by two new products—a singlefold (10" by $10\frac{1}{2}$") and a multifold ($9\frac{3}{8}$" by $9\frac{1}{2}$") towel—to make a full industrial towel line available in three price ranges. The complete line is available through regular paper jobbers.

◆ ◆ ◆

Super-contact freezing on each shelf is combined with economical operation in the **new line of upright freezers** introduced by Nor-Lake, Inc., Hudson, Wis. A cooling coil for each shelf and double-type inner doors are largely responsible for these efficiency producing features. Improved economy and prevention of frost formation on coils is afforded by the hinged doors which prevent loss of cold air when the main door is opened. The $3\frac{1}{2}$" wall of Fiberglas insulation further augments this efficiency factor. Quick freezing and easy cleaning are made possible by the stucco-finish aluminum interiors. Placement of the copper coils insures that no spot in the Nor-Lake freezer is over 5" from a coil, while a heater strip around the door opening prevents sweating. Available in six models, the freezer may be obtained in capacities of 17, 20, and 27 cu. ft.

◆ ◆ ◆

A contract to provide 100 refrigeration systems for Pacific Fruit Express Company railroad cars was announced by Carrier Corp., Syracuse 1, N. Y. The units feature a 40% reduction in power requirements, allowing for a smaller, more compact generator. The new systems are all-purpose in that they heat as well as cool, providing for constant temperature despite outside changes of climate. A tempera-

(Continued on page 56)

How Sunkist helps you...

In every field of food processing, new contributions are being made toward tomorrow's better foods. Look at these typical Exchange Brand developments, based on 50 years of Sunkist research.

EXCHANGE
OIL OF LEMON

Unmatched quality and flavor that come only from quality California lemons . . . grown and skillfully processed by exacting Sunkist standards. The 4-to-1 favorite over **all other lemon oils combined!**

EXCHANGE
PRESERVER'S PECTIN

Here is **even** jell strength that guarantees a more consistent, uniform, finished product . . . a smooth, perfect texture and complete reliability in setting control.

EXCHANGE
LOW METHOXYL PECTIN

A natural fruit pectin that jells without sugar. Completely tasteless, permitting the use of the most delicate flavors . . . allows the natural juicy fruit flavor to come through. Controls "running" or "weeping" in pies when cut. Famous too for aspics, jellied fruit or vegetable salads, dietetic preserves or non-sugar jells.

EXCHANGE
OIL OF ORANGE

By far the best orange oil by any laboratory measurement. Always consistent, richer in flavor strength and more intense in aromatic constituents. Standard the world over for orange flavor excellence.

EXCHANGE
LEMON JUICE

Brings out the natural flavor of **any** food product. A superior acidulant in the preparation of mayonnaise, fruit cocktail, figs, fruit nectar, prunes and other heavy-syrup products. Highly effective as an anti-oxidant in processing frozen foods, particularly frozen fish products. Available in concentrated or single strength form.

Sunkist Growers

Exchange®

PRODUCTS DEPARTMENT • ONTARIO, CALIFORNIA

(Continued from page 54)

ture range from —10° to 70° F. is possible, depending on the thermostat setting. The units are designed to "think by themselves" as they are unattended for as long as 14 days on a cross-country trip. Defrosting is automatic, with the electric heater tripped into action when the cooling coils become frosted enough to hamper the flow of air.

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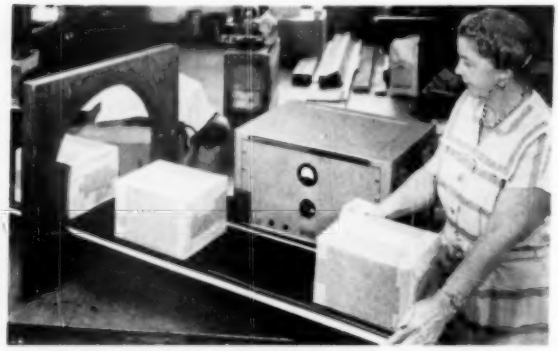

New Model TM Metal Detector automatically signals the presence of tramp metal particles hidden in non-metallic materials, either packaged or in bulk. Among products which can be inspected automatically at conveyor speeds up to 1000 fpm are: foods, plastics, confections, and pharmaceuticals. The Detector is sensitive to both ferrous and non-ferrous particles. Contaminated material passing through the test coil causes a reject relay to sound a warning gong, trigger a marking device, or operate a reject gate. Inspection apertures can be made any convenient size and may be mounted in any position to permit passage of the product. Write J. W. Dice Co., 16 Highwood Ave., Englewood, N. J.

◆ ◆ ◆

International Register Co., 2620 W. Washington Blvd., Chicago 6, Ill., recently announced addition of seven new time switches to its Intermatic line. The new models offer more accuracy and versatility in control of electric circuits from periods of two seconds to 24 hours. For complete information request Bulletin NR 106.

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Haveg Industries, Inc., 900 Greenbank Rd., Wilmington 8, Del., is manufacturing tanks and equipment from a polyester fiberglass combination approved for vinegar processing and storage. Strong, tough, and durable, the tanks are resistant to attack of acid foods, and heat-resistant for continuous use to 260° F. In certain applications, this resistance to acid reportedly is far superior to that of stainless steel. The tanks also are extremely light—a 600-gal. capacity tank weighing 150 lbs.—and substantially lower in price than tanks of corrosion-resistant metal in corresponding sizes. The firm offers sizes up to 30,000 gal., and also designs tanks for individual requirements.

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A new import from Italy—the Vespa Van, built on three wheels and mechanically patterned after the motor-scooter—has an initial cost of about one-half that of the smallest standard panel truck, and running expenses are approximately one-fourth as much. The Van has a carrying capacity of over 700 lbs., and can get more than 70 miles from one gallon of fuel, while running at 35–40 mph. Mounted on torsion bars and double-acting hydraulic shock absorbers, the van section of this 6 hp, two-stroke machine is ideally suited for even very fragile items. It has four forward speeds and one reverse, and can take a 20% upgrade with full load. Write Vespa Distributing Corp., 270 Park Ave., New York 17, N. Y.

◆ ◆ ◆

A new line of high capacity Universal Separators, designed for separating milk from 40° to 120° F., is announced by Sharples Corp. The units provide the highest available separating efficiency without sacrificing large sediment holding capacity. Write Renner Advertisers, 1530 Lombard St., Philadelphia 46, Pa.

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The "Data-line"—a new can coding instrument, designed to reduce marking and coding costs by 60 to 80%—has been introduced by Triple-E Engineering Co., Racine, Wis. Developed to eliminate objections to current separate operations for embossing, printing on metal or perforating, and printing or notching of labels, the "Data-line" becomes a part of the canning line and is installed right in the conveyor system at a transfer point. The unit is precision engineered to permit scratches of microscopic depth, visible when one is looking for them, but not deep enough to penetrate the can coating to the point where corrosion may occur. Selling price is $280.

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A new line of Torit cyclone-type dust collectors featuring connections to standard 55-gal. drums has been introduced by Torit Mfg. Co., 287 Walnut St., St. Paul 2, Minn., for use in installations where large volumes of bulky, sticky dust are created. Known as the Series 55 collectors, their exhausting capacities range from 1000 to 1100 cu. ft. of air per minute at speeds in excess of a mile a minute. Cyclone-type collectors use centrifugal force to precipitate all but the finest dust particles, up to 95%, with the other 5% being exhausted outside or trapped in an efficient after-filter bag. F.o.b. factory prices range from $375 to $448 (not including drum).

◆ ◆ ◆

A penny candy item, popular 25 years ago in bulk sales, has met with wide acceptance in a cellophane overwrapped tray designed especially for modern self-service supermarket merchandising. Keppel's

(Continued on page 58)

Institute of Food Technologists

THE PROFESSIONAL SOCIETY OF FOOD TECHNOLOGISTS

The Institute of Food Technologists numbers among its active members leading scientists, technologists and engineers in the field of Food Technology.

The Institute invites your professional association with this select group of scientific and technological workers. Only those who are qualified by education, special training, or experience are extended this invitation.

Food Technology may be defined as the application of science and engineering to the production, processing, packaging, distribution, preparation and utilization of foods. Scientists, technologists and engineers engaged in Food Technology, executives, officials and supervisors under whose jurisdiction Food Technology operations are conducted, research investigators, teachers, and others working in the field of Food Technology, will find membership in the Institute worth many times its modest cost.

If you can meet the qualifications for membership, you owe it to yourself and to your business or profession to become a member.

OBJECTIVES

The Institute is a non-profit, professional, educational association to promote the application of science and engineering to the production, processing, packaging, distribution, preparation, and utilization of foods; it stimulates investigations into technological problems arising therein, it provides a medium for presenting and discussing the results of such investigations; it stimulates and provides means for the free interchange of technological information and ideas among food technologists; it promotes recognition of the role of food technologists in the technical direction of operations in these fields; all of these activities have the ultimate objective of providing better and adequate foods for mankind.

ORGANIZATION AND PROGRESS

Organized July 1, 1939, at Cambridge, Mass., with a membership of less than 100, the Institute has grown to more than 4,900 (1956). It is world-wide in scope, with members in North, Central, and South Americas, the Scandinavian countries, England, Holland, Germany, France, India, Australia, and New Zealand.

MEMBERSHIPS

Professional Members. Any person who is ethically qualified, and who has had training and experience in food technology, or any person who in the opinion of the Council is recognized as distinguished in the contributing sciences as they apply to foods, shall be eligible to be a Professional Member of the Institute. The minimum training which shall qualify a candidate for eligibility for Professional Member is, in general, graduation from a college, university, or similar institution in which he has majored in one or more of the sciences or branches of engineering associated with food technology. The minimum experience shall be three years experience in food technology. The Council may, at its discretion, waive any or all of the foregoing requirements in the case of a person who, thru long experience, has distinguished himself in the field of food technology.

Members. Any ethically qualified person, active in special or limited aspects of food technology, who is an administrator, director or executive under whose jurisdiction operations in food technology are conducted; or who is engaged in the dissemination of knowledge of food technology; or one whose work requires a general knowledge of the broad principles of food technology as it applies to the products, processes or equipment with which he or she is concerned; or one scientifically trained in and who has entered a career in food technology; shall be eligible to become a Member.

Student Members. Any ethically qualified person who has never been a Professional Member or Member of the Institute, who is registered as a student in an educational institution with at least Junior (third year) standing, who is a candidate for a Bachelor's or higher degree in one or more of the sciences or branches of engineering associated with food technology, shall be eligible for membership as a Student Member. This classification shall be his status only until the end of the calendar year in which he completes his schooling. When graduated and otherwise qualified as defined in the section on "Members," a Student Member may, upon application, be elected to Membership.

DUES

Professional Members and Members—$7.50 per year; Students—$2.50 per year. Dues include a subscription to FOOD TECHNOLOGY.

PUBLICATIONS

FOOD TECHNOLOGY, issued monthly, is the official journal of the Institute. It is published to advance the profession of food technology by disseminating the results of research and their practical application in industry. Contributors to its pages represent many fields of scientific and technological interest.

FOOD RESEARCH, published bi-monthly, is devoted to publication of the results of original investigations and occasional reviews in the fields of food and beverage technology, chemistry, and microbiology. FOOD RESEARCH is available to Institute members at the special rate of $7.50 per year.

REGIONAL SECTIONS

Where sufficient members (25 or more) live within commuting distance of a given point, a Regional Section may be established. Such Sections are able to hold meetings at more frequent intervals than the National group, thus affording the food technologists regular opportunities for an exchange of views and ideas with others in the area. There are presently 25 Regional Sections.

ANNUAL MEETINGS

Each year one of the regional sections acts as host to the Institute at an annual meeting. The program of this annual conference is designed to acquaint members with various phases of food production, processing and distribution, and to keep them abreast of current trends and technological developments. The speakers invited are those whose subjects will build a well-rounded program, of interest to the greatest number. Annual conferences are highlighted by exhibits of new equipment, processes and special ingredients.

AWARDS

The society administers the following awards:

NICHOLAS APPERT AWARD (Medal). Each year the Chicago Section of the Institute makes this award to a person whose contributions to the food industry make him distinguished and outstanding in the opinion of the national jury.

BABCOCK-HART AWARD ($1,000.00). The purpose of this award, made by the Nutrition Foundation, is to encourage contributions to FOOD TECHNOLOGY which will have an influence on the nutritional well-being of the general population.

FLORASYNTH FELLOWSHIP AWARD. $1,000 granted annually to a young man or woman under 35 years of age, engaged in senior undergraduate or graduate work, as a candidate for an advanced degree, in recognized educational institutions in the United States or Canada, which is conducting fundamental investigations for the advancement of Food Technology.

GENERAL FOODS FELLOWSHIP AWARDS. Three Fellowships will be granted annually—no more than two to the same educational institution for the same calendar year, but will be renewable upon application to and approval by the Awards Committee of the Institute for a maximum of three years, in order to provide for continuity of studies leading to a doctorate degree, if the candidate so plans. However, candidates, who plan only a year of research after obtaining the Bachelor Degree, or who plan to read for a Master's Degree, will not be excluded from these fellowship grants. Each Fellowship is worth approximately $4,000.

GERBER BABY FOODS SCHOLARSHIPS. Six undergraduate Scholarships at $1000 each, per year, intended to cover the last two school years leading to a Bachelor's degree in Food Technology, Food Engineering, or Food Science.

(Continued from page 56)

Inc., Lancaster, Pa., is marketing its marshmallow-twist candy in a printed tray and window lid, with an AVISCO 450 MS cellophane overwrap applied by a Hayssen automatic wrapper. As proof of the success of this multi-item package, Keppel's sales have multiplied ten times in two years.

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New design and corrosion-resistant stainless steel construction are featured in the Vic Heat Exchanger, manufactured by Vic Mfg. Co., 1313 Hawthorne Ave., Minneapolis 3, Minn. The new design permits liquid to flow freely through a larger cooling area instead of through numerous small tubes, providing for more heating (or cooling) in a given time. Another new feature is removable coils. The firm also offers controls for these units which automatically regulate temperatures for heating or cooling.

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A new, portable moisture determinator is announced by Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill. The Cenco Karl Fischer Moisture Determinator is completely self-contained, weighs only 22 pounds, and can analyze liquid, solid, and gaseous samples without removing the basic apparatus from the case. The instrument, which operates on 115 volt, 60 cycle current, is recommended for moisture determinations on edible oils, soaps, fats, waxes, dry food products, and many other materials. Accurate results are obtained whether water content of sample is a few parts per million or over 50%. Accuracy of determinations varies from plus or minus 10% in the 0 to 100 p.p.m. range, to plus or minus 0.2% in the higher ranges. Measurements, when closed, are: 21¼" wide, 11¼" high, and 7⅞" deep. Selling price is $472.50 with stirrer, two 25-ml. burettes and necessary drying tubes, and case, but without pipettes or chemicals. Central Scientific has been licensed for manufacture and sale of the unit by Phillips Petroleum Co.

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Providing exact control with a minimum of equipment, the new SWISSTROL electronic-hydraulic control unit solves control problems involving pressure, vacuum, temperature, liquid level, flow, or condensate drainage, and is adaptable to practically any manufacturing process. The compact unit's speed of action eliminates problems of "lag" and "hunting." Only one moving part makes for almost friction-free operation and low maintenance cost. Each unit is custom-built to the customer's exact specifications, and is guaranteed for 30,000 hours of operation. Full purchase price is refunded if the equipment does not function to customer's specifications. Write Engineering Division, The Swiss Colony, Monroe, Wis.

◆ ◆ ◆

More efficient and increased production in icing and filling operations are possible with the new 1956 Mallet Sr. Icing Depositor. Meeting highest sanitation standards, the new mobile unit assures continuous, uninterrupted production. The wide range of speeds at which motor and pump operate allows synchronization with any speed of the conveyor. A simple adjustment makes possible application of sealed amounts of icing to baked goods. Write Mallet & Co., Inc., 601 E. General Robinson St., Pittsburgh 12, Pa.

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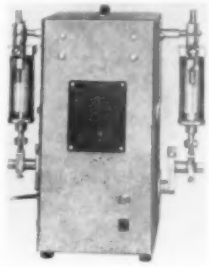
Up to eight ounces of liquid per stroke can be dispensed with the new Filamatic Model DAB-6 Filling Machine recently introduced by National Instrument Co., 2701 Rockwood Ave., Baltimore, Md. The unit will dispense free-flowing or semi-viscous fluids, including aqueous solutions, oils, syrups, suspensions, and saturated solutions at rates variable from three to 60 fills per minute. Volume of fill is adjustable from .002 oz. to 8 oz. per stroke. Vials can be filled singly, two at a time, or in multiples of two. For filling vials in multiples, two or more machines are coupled together by means of a low-cost Synchronizer Attachment. The latter also permits the Filamatic to be installed on a customer's conveyor for completely automatic operation.



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Used extensively as softening agents because of their excellent hygroscopic properties, Jefferson ethylene-, diethylene-, and triethylene-glycol are capable of absorbing almost twice their weight of water at room temperature and 100% humidity. Being dihydric alcohols, these glycols react with poly-basic acids to produce polyester materials. Completely miscible in water, they dissolve many organic chemicals. In soluble oils, the glycols function as coupling agents between fatty acids and soaps, producing more stable emulsions. Write Jefferson Chemical Co., Inc., Box 303, Houston 1, Texas.

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Two new white milo starches—SnowFlake 4823 for canned pie fillings, and SnowFlake 4828 for fillings made from fresh and frozen fruit—are announced by Corn Products Sales Co., 17 Battery Pl., New York 4, N. Y. Formulated for both large commercial manufacturers and neighborhood retail bakers, the new starches produce unique gel characteristics which eliminate "weeping," hold the fruit in even distribution throughout the mass, and prevent setback

(Continued on page 60)

EXECUTIVE OFFICES: **900 VAN NEST AVE.,** (BOX 12) **NEW YORK 62, N. Y.** • CHICAGO 6 • LOS ANGELES 21

Cincinnati 2 • Detroit • Dallas • Memphis • New Orleans 12 • St. Louis 2 • San Francisco • San Bernardino

Florasynth Labs. (Canada Ltd.) • Montreal, Toronto, Vancouver, Winnipeg • Agts. & Dist. in Mexico: COMSOLMEX S.A. Mexico 11, D.F.

(Continued from page 58)

or drying up of the filling during long periods of refrigeration. SnowFlake milo starches allow major production economies since they permit the baker to rehandle and remix fillings in a finished state without lumpiness—even after storage. Final consistency may be determined immediately after cooking because fillings retain the same body characteristics hot or cold.

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A low-cost medium-speed machine for loading cans into multiple packages has been designed by Container Corporation of America, 38 S. Dearborn St., Chicago, Ill. The Can Band Loader will load up to 50 cartons a minute, and handles two-, three-, and four-can multiple packages. Canners lease the machine by the month as they need it. It also is available permanently as part of medium-speed production lines.

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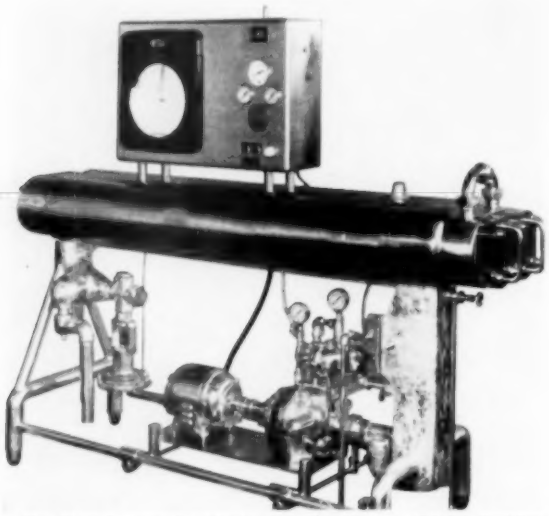

The Roswell "super" preheater, manufactured by Chicago Stainless Equipment Corp., 5001 Elston Ave., Chicago 30, Ill., is an automatically controlled unit specifically designed to process foods at unusually high temperatures unattainable in other heat exchange equipment without impairment of product flavor, body, texture. The two-tube model handles 4,000 to 22,000 pounds-per-hour, and the four-tube unit handles 8,000 to 44,000 pounds-per-hour, depending on product and temperature range. Both units come completely equipped with product and steam controls, stainless steel panel board, and condensate feed and return pump system. Use of spiraled tubes, allowing the product to be heated from both sides at high velocity with small quantities being continuously processed, reportedly brings superior results.

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New plastic conveyor belts fabricated by joining two sheets of Du Pont's "Mylar" polyester film with a special white adhesive are being used by more than 100 companies in the candy, baking, and other food processing fields. The smooth surface of the belt has provided a "new look" for many chocolate covered candy and ice cream products by imparting a glossy appearance to the bottoms similar to the coating on top and sides. Its low weight of 0.04 pounds per sq. ft. makes belting of "Mylar" only a twelfth as heavy as the lightest woven material. Write E. I. Du Pont de Nemours & Co., Wilmington, Del.

Packaging of meat and other foods in films and containers plasticized with Paraplex G-62, a high molecular weight polymeric-type plasticizer, is acceptable to both the FDA and the Meat Inspection Branch of the USDA. Some of the foods which may now be packaged in plastic materials containing this plasticizer include bacon, lard, and other products of federally inspected meat plants, margarine, and water-containing foods such as fruits and vegetables. Further information, including a summary report of a toxicity study, can be obtained from Resinous Products Division, Rohm & Haas Co., Washington Sq., Philadelphia 5, Pa.

. . . *the literary corner*

Concurrent with its entry into the field of niacin production and marketing, the Tar Products Division of Koppers Co., Inc., 1450 Koppers Bldg., Pittsburgh 19, Pa., has issued a new bulletin on this exceptional nutrient and ingredient for pharmaceuticals. Entitled "Koppers Niacin," 4-page Bulletin T-102-56 gives a general description of the applications of niacin for human nutrition, plant nutrition, animal nutrition, and for the formulation of B-complex vitamin tablets and capsules.

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A picture-book tour of its new integrated center of metal container research and development is available in the form of a color brochure, "New and Bet-

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

October 9-12	American Dietetic Association, Milwaukee, Wisconsin
October 17-19	Nat'l Pickle Packers Association, Edgewater Beach Hotel, Chicago
October 23-26	Annual Meeting of the Association of Food Industry Sanitarians, Casa Munras Hotel, Monterey, California
November 12-15	American Bottlers of Carbonated Beverages, Public Auditorium, Cleveland, Ohio
November 27-30	National Chemical Exposition, Public Auditorium, Cleveland, Ohio
1957	
January 21-24	Annual Winter Meeting of the National Macaroni Manufacturers Association, Flamingo Hotel, Miami Beach, Florida
February 12-14	Technical School for Pickle Manufacturers, Kellogg Center, Michigan State University, East Lansing, Michigan
February 26-27	Fifth Annual National Dairy Conference, Kellogg Center, Michigan State University, East Lansing, Michigan
April 23-25	Annual Meeting of the Research and Development Associates, Jefferson Hotel, Richmond, Virginia
May 12-16, '57	**Institute of Food Technologists, Seventeenth Annual Meeting, Pittsburgh, Pa.**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

ter Containers," published by Continental Can Co., Inc., 100 E. 42nd St., New York 17, N. Y.

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"Orange—Variety in Flavor" is the article comprising *The Givaudan Flavorist*, No. 4, 1956, published by Givaudan Flavors, Inc., 330 W. 42nd St., New York 36, N. Y.

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A new 28-page manual, Tygon Flexible Plastic Tubing, Bulletin T-97, available without cost from The U. S. Stoneware Co., Akron 9, Ohio, covers each of the many Tygon Tubing formulations individually and in technical detail.

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A thoroughly revised edition of its king-size catalog, containing over 1,000 listings of essential oils, balsams, concentrated flavors, oleoresins, basic perfume oils, aromatic chemicals, and certified colors, for use in the cosmetic, pharmaceutical, confectionery, food, chemical specialties, and allied industries, has been published by Magnus, Mabee & Reynard, Inc., 16 Desbrosses St., New York 13, N. Y. Address the firm's advertising department.

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"Glycerine Properties and Uses," a 17-page illustrated booklet describing the chemical and physical properties and the many diverse industrial applications of glycerine, has been issued by Glycerine Producers' Assn., 295 Madison Ave., New York 17, N. Y. Also available is a 19-page booklet entitled "Glycerine Terms, Tests, Technical Data."

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Bulletin 498, containing latest information about the Beckman Electrolytic Hygrometer, Bulletin 488 on the new Beckman RF Gas Analyzer, and Bulletin 495, describing new explosion- and corrosion-proof accessories for the Beckman L/B Infrared Analyzer, are available from Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

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A new edition of "13 Suggestions to Help You . . . Get the Most Out of Industrial Trade Shows" is offered without charge by the Convention Bureau of Standard Printing Service, 30 N. Dearborn St., Chicago 2, Ill.

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A directory of the nation's leading suppliers of advertising essentials and sales aids has been announced by Advertising Trades Institute, Inc., 135 E. 39th St., New York, N. Y. The Fall edition of ATI's Buyers' Guide lists over 100 classifications of national suppliers. Write Thomas B. Noble, ATI chairman, for information.

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"The world is changing its eating habits. According to a recent Government report, Western Europe is consuming more fruit, milk, and cheese than before the war; bread is replacing rice in some countries of

Can science enhance ancient flavor traditions?

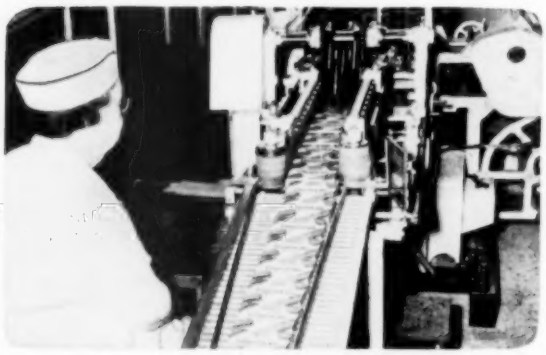
Givaudan says *yes.* And our research laboratories, known throughout the world for their work in the development of flavors for every purpose, invite you to investigate the specific flavors we offer for cordials, brandies, wines and liqueurs. Why not call us right now?

Givaudan Flavors Inc.

330 West 42nd Street
New York 36, New York

how 4 Fishermen made a big haul with Ac'cent

The Fulham Brothers beam as sales of 4 Fishermen pre-cooked frozen fishsticks continue their upward surge. Sales are up 85% since 1954.



Packaged and ready for market! Processors of both canned and frozen foods have found that Ac'cent gives their products a competitive edge on flavor.

Business up 85% in 2 years!

THE four smiling faces on the 4 Fishermen package are reflected many times in the sales department of Fulham Brothers, of Boston and Portland. Sales of their frozen fishsticks have been climbing in an amazing fashion since their introduction in 1954.

One contributing reason is the use of Ac'cent, to build and hold flavor in the cod and haddock. Fulham Brothers buys prepared batter and breading containing Ac'cent. They also add 4 ounces of Ac'cent to every 18 pounds of batter to insure consumers of the finest flavor and to promote repeat business for 4 Fishermen.

Hundreds of leading food processors use Ac'cent to heighten and hold true food flavors, and to guard against flavor loss in packing, shipping and storage.

Isn't the precious flavor of *your* products worth protecting with Ac'cent? Ac'cent technical representatives will aid you in determining the amount best suited for your product. Call or write today to

Ac'cent® *Remember flavor builds your business, and Ac'cent builds flavor!*

BRAND
Pure Monosodium Glutamate
AC'CENT • INTERNATIONAL, 20 N. Wacker Drive, Chicago 6, Illinois

southeast Asia; and here at home we are eating less grain products and potatoes and more eggs, green vegetables, citrus fruits, and tomatoes." Thus begins the latest in an excellent series of articles on The Changing World of Food appearing in *D&O News*, published by Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y. Part XI—What Does the Future Hold?—appears in the September 1956 issue.

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A comprehensive book, "The Answers to Your Questions About Layne Vertical Turbine Pumps," is available without charge from Layne & Bowler, Inc., Memphis 8, Tenn. The 72-page, hand-bound book covers the use of pumps for municipalities, industry, and irrigation. Request copies on company letterhead.

◆ ◆ ◆

A high-speed, high-shear homogenizer-mixer called the Eppenbach Homo-Mixer, is described and illustrated in new 8-page Catalog 402-R-2 offered by Gifford-Wood Co., Hudson, N. Y.

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A new brochure describing two unique tapes—Permacel 97, made of acetate fiber, and Texcel 45, made of cellophane—for use in printing, packaging, and identifying is available from Permacel Tape Corp., New Brunswick, N. J.

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Data Sheet Uc, available from The Allen-Sherman-Hoff Co., 259 E. Lancaster Ave., Wynnewood, Pa., describes the new A-S-H Type B continuous mixer and unloader. This equipment removes ash or other dry material from storage bins, mixes it with water, and discharges it into waiting trucks or rail cars.

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Data Memorandum No. 1, published by Superior Tube Co., 1697 Germantown Ave., Norristown, Pa., lists 121 metals and alloys from which the firm produces its standard and special small diameter tubing.

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Bulletin No. 2515, 24 pages, published by Chemical Plants Division, Blaw-Knox Co., Pittsburgh, Pa., describes and illustrates "Plants and Processes for the Fats and Oils Industry."

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The complete line of Stokes industrial compacting presses is described in new 24-page catalog No. 816, issued by the Tabletting Division of F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.

◆ ◆ ◆

Ace Supplex flexible polyethylene plastic pipe and fittings are described in 8-page Bulletin CE-57, issued by Supplex Co., Division of American Hard Rubber Co., 93 Worth St., New York 13, N. Y. Of

particular interest to the industrial buyer is a chart which lists many common industrial liquids—acids, bases, organic chemicals, etc.—and specifies which of these may be carried in Supplex piping. The piping of non-toxic, virgin polyethylene, is approved by the National Sanitation Foundation for use with drinking water.

◆ ◆ ◆

A handy reference data kit for cheesemakers is offered free by Marshall Dairy Laboratory, Inc., 14 Proudfit St., Madison 3, Wis. The kit consists of a 9½" by 11¾" portfolio containing technical bulletins for the cheesemaking industry.

◆ ◆ ◆

A new 8-page bulletin on their complete line of hydrometers and thermo-hydrometers for use when accurate indications of specific gravity or other density scale are required, has been issued by Precision Thermometer and Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa. Write for Bulletin G-3.

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Catalog 91-1709, describing the firm's batch control systems, is available from Fischer & Porter Co., 812 Jacksonville Rd., Hatboro, Pa.

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Copies of a new illustrated booklet, "A Coordinated Sanitation Program for Dairies," is available from Oakite Products, Inc., 19 Rector St., New York, N. Y., manufacturers of industrial cleaning and sanitizing materials and equipment.

. . . *meeting hall and conference room*

A series of 12 papers evaluating "Automatic Data Logging Systems" from the viewpoints of management, labor, production, and finance will be presented at a two-day symposium in Philadelphia on November 7-8, 1956. To be held in conjunction with an equipment exhibit at the Bellevue-Stratford Hotel, the symposium is sponsored by the Philadelphia Section of the Instrument Society of America. Further information is available from Horace Richter, symposium chairman, Fischer & Porter Co., 29 Bala Ave., Bala-Cynwyd, Pa.

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The Grocery Manufacturers of America will hold its 1956 annual meeting in New York at the Waldorf-Astoria Hotel November 12-14. Theme of this year's meeting will be "The Responsibility of Leadership from Farm to Family."

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The Society for Analytical Chemistry, 7-8 Idol Lane, London, E. C. 3, England, through its Scottish Section, is organizing a Congress to be held June 24-28, 1957, at St. Andrews University, Scotland, at which new developments in chemical analysis will be discussed and the possible directions of new advances in the future will be reviewed.

◆ ◆ ◆

The 20th Annual Conference of the National Potato Chip Institute will be held at the Statler-Hilton Hotel, Dallas, Texas, January 20-24, in connection with the observance of National Potato Chip Week. For information, write Harvey F. Noss, executive vice president, The National Potato Chip Institute, 946 Hanna Bldg., Cleveland, Ohio.

. . . *building up and branching out*

Plans for construction at Hammond, Ind., of its first plant devoted exclusively to the processing of tinplate have been announced by American Can Co. The Hammond installation, which will employ some 500 persons initially, is expected to be completed late next spring. It is one of Canco's first steps in a previously announced $27 million program for large-scale plate-processing facilities throughout the country to combat rising steel prices.

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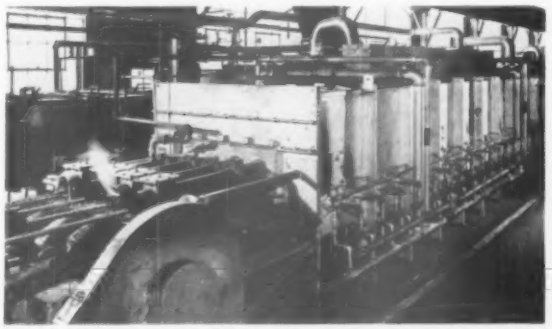

Believed to be the largest of its kind in the stainless tube industry, a new continuous bright annealing furnace capable of maintaining a high quality finish on welded stainless steel tubing from ⅛" O.D. to 4" O.D., has been installed at the Steel & Tubes Division of Republic Steel Corp., Cleveland, Ohio. Capable of producing a high quality finish without polishing for many applications, it can eliminate the high cost of polishing borne by the tube purchaser. It also does away with much of the ordinarily required pickling operations.

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Ten of America's large corporations have formed a new company, Industrial Reactor Laboratories, Inc., to build and operate a privately owned nuclear reactor for industrial research in atomic energy at Plainsboro, N. J. Companies participating are Atlas Powder Co., AMF Atomics Inc. (subsidiary American Machine & Foundry Co.), American Tobacco Co., Continental Can Co., Corning Glass Works, National Distillers Products Corp., National Lead Co., Radio Corporation of America, Socony Mobil Oil Co., and United States Rubber Co. Each participant is represented on the new firm's board of directors, which

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will be headed by Gen. Walter Bedell Smith, president, and H. L. Hilyard, vice president. Gen. Smith is chairman and president of AMF Atomics Inc., and Mr. Hilyard is treasurer of American Tobacco Co.

◆ ◆ ◆

Purchase of the Hathaway plant in Boston was announced by Minneapolis-Honeywell Regulator Co. The 3-story, 250,000 sq. ft. plant will house Honeywell's Transistor Division, scheduled for transfer to Boston from its present Minneapolis location. The activities and administration will be integrated with those of Honeywell's Doelcam Division, also located in Boston. Production facilities for manufacture of the Doelcam Division's line of gyroscopes, synchro motors, and other precision electro-mechanical servo components also will be consolidated in the new plant. George J. Schwartz, vice president and general manager of the Doelcam Division, said the new plant would ultimately employ 1500 people—approximately 600 of these being new jobs.

. . . *the human element*

Miles J. Willard, Jr., has joined the staff of Rogers Bros. Seed Co., Idaho Falls, Idaho, where he will head research and quality control in the Food Products Division. A former Philadelphia IFT member, Willard was project leader of the potato flake development at the USDA's Eastern Regional Research Laboratory, Wyndmoor, Pa.

◆ ◆ ◆

Dr. Leo J. Novak, a member of IFT, has been promoted to vice president, chemical director, of Commonwealth Engineering Company of Ohio, Dayton. Holder of some 30 patents in various fields, he has developed a number of new chemical processes, including one for new effervescent drinks, and has headed up research in gas plating and in commercial utilization of dextrin derivatives.

. . . **Novak of CECO**

◆ ◆ ◆

Clifford J. Robertson, an active member of the Ohio Valley Chapter of IFT, has been transferred from the Product Research Department of The Procter & Gamble Company in Cincinnati to the firm's sales office in New York City as Eastern Regional technical sales representative in the Bulk Shortening Sales Department.

. . . **NYC for P&G's Robertson**

◆ ◆ ◆

Stanley I. Skelskie has joined Loblaw's, Buffalo, N. Y., as head of the Products and Quality Control

Department. For the past ten years, IFT member Skelskie has been with The Welch Grape Juice Company, Inc., in positions in engineering, research and development, operations, and quality control.

◆ ◆ ◆

Dr. Robert E. Payne has been named director of research for Sharples Corp., centrifugal and process engineers, Philadelphia. In addition, he will serve as technical advisor on production of centrifugal equipment manufactured by the firm for use in the chemical, oil, food, and other process industries.

◆ ◆ ◆

. . . Howard . . . recognized for Acronized

Appointment of **John H. Howard,** who formerly headed the merchandizing program for Acronized, to the newly created position of manager of sales, Food Industry Department, American Cyanamid Co., has been announced. In his new post, he will be in charge of all sales, merchandizing, and promotion activities of the department, which includes the Acronized process for maintaining the freshness of poultry, developed and introduced by Cyanamid late in 1955.

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The Quartermaster Food and Container Institute for the Armed Forces, 1819 W. Pershing Rd., Chicago, announces the appointments of **Dr. Ferdinand Heinmetz** to the newly created position of physicist with its Radiation Preservation Branch, and **Dr. George W. Kurtz** as head of its newly established Flavor Chemistry Laboratory. Dr. Heinmetz, a native of Estonia, received his doctorate from the University of Pennsylvania and most recently was chief of the Biophysics Department in the Naval Medical Field Research Laboratory, Camp Lejeune, N. C. His principal concerns will be investigating the characteristics of sources of ionizing radiations and helping develop dosimeters which meet food preservation requirements. Dr. Kurtz received his Ph.D. from The Pennsylvania State University, and recently completed two years of military service as a scientist at the Quartermaster Institute. Early this year, he received the annual Research Directors' Award of the Quartermaster Research and Development Command for his work in developing an efficient and commercially feasible process for removing oxygen from hermetically sealed containers. In his new civilian capacity, working under the direction of the Institute's Chemistry and Microbiology Branch, he will be concerned with studies of changes in food flavor, odor, and texture during processing and storage.

◆ ◆ ◆

In a continuing program of expansion, Evans Research and Development Corp., 250 E. 43rd St., New York 17, N. Y., has added three more research chemists to its technical staff. The three are **Gerald Fishman,** formerly of Affiliated Research, Inc., **Miss Ruth Fierman,** formerly of Jacobs Winston Laboratories, and **Stanley Lerner,** formerly of Columbia University.

◆ ◆ ◆

Foam atop an open fermenting vat attracts the attention of two Turkish professors as they visit the Miller Brewing Company, studying fermentation methods employed at the modern Milwaukee brewery. From left are Tom Kissel, head bacteriologist at Miller; Dr. Tamet Tucker and Dr. Turgut Yazicioglu, technology professors in the College of Agriculture at Ankara University, and Larry Neuman, Miller quality control supervisor.

◆ ◆ ◆

The Chemical Sales Division of Chas. Pfizer & Co., Inc., Brooklyn, announces four personnel changes.

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Edward W. Marlier, formerly sales representative in the Pittsburgh and Cleveland areas, has been assigned to the headquarters staff of the Industrial Chemicals Department in Brooklyn. **Carl W. Lorentzen,** chemical sales representative, has been assigned to serve customers in the Pittsburgh and Cleveland areas. **Walter Gropler** has been assigned as field sales representative in the Metropolitan New York area, and **Simon Sluis** will serve as a representative in the Pacific Northwest area.

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. . . new V.P. Meilstrup of Diamond Crystal

Spencer S. Meilstrup, general sales manager of Diamond Crystal Salt Co., St. Clair, Mich., has been elected a vice president. His promotion creates a new elective office in the salt company that was formed in 1953 when the Moore family regained ownership of the 70-year-old business by purchasing the company's assets from General Foods Corp., owners since 1929.

◆ ◆ ◆

. . . CCC's high polymer chemist Mesrobian

Dr. Robert B. Mesrobian, formerly associate director of the Polymer Research Institute of the Polytechnic Institute of Brooklyn, has been named associate director of research, High Polymer Chemistry, for Continental Can Company's newly created Central Research and Engineering Division. He is a consultant to the Nuclear Engineering Division of Brookhaven National Laboratory, and his past industrial experience includes consulting work for numerous companies which develop, produce, and use resins and polymeric materials. The newly formed Continental Division, headed by Curtis E. Maier, eventually will employ 100 people, about 75 of whom will be professional scientists with outstanding experience and demonstrated ability in their specialized fields.

◆ ◆ ◆

Kenneth R. Brown, vice president and director of Atlas Powder Co., Wilmington, Del., retired on August 30 after 38 years' service. His pioneering work in developing the commercial production of sorbitol won him the 1955 honor awards of both the ACS Division of Carbohydrate Chemistry and the Commercial Chemical Development Assn.

◆ ◆ ◆

Dr. E. W. Eickelberg has been named plant manager of Chun King Sales' newly acquired Jackson, Ohio, plant. The 94,000 sq. ft. building, purchased last June, already is in operation for limited warehousing and distribution of canned and frozen Chun King products. Dr. Eickelberg formerly was plant manager for Stokely-Van Camp.

◆ ◆ ◆

E. R. Durrer, president of The Givaudan Corporation and its associate companies, Givaudan-Delawanna, Inc., Givaudan Flavors, Inc., and Sindar Corp., has returned to the U. S. after an extended trip to Europe. He reports that the countries of Western Europe are participating in the present boom.

◆ ◆ ◆

. . . Felton's Stan Maas

Felton Chemical Co., Inc., 599 Johnson Ave., Brooklyn 37, N. Y., announces the transfer of **A. Stanley Maas** to Felton's midwest headquarters in Chicago, out of which he will cover Western Michigan, Indiana, and Illinois, and appointment of **Noah N. Showe** to the Detroit field staff, from which headquarters he will service Eastern Michigan, Ohio, and West Virginia.

◆ ◆ ◆

. . . Burke of Flex-Vac

A veteran of 19 years with Milprint, Inc., and eight years with Shellmar Co., **Edward F. Burke** has been appointed to the sales organization of the Flex-Vac Division of Standard Packaging Corp., 551 Fifth Ave., New York, N. Y. At Shellmar, he was general manager of sales for both the Shellmar Company and the Shellmar-Betner Division of Continental Can Co.

◆ ◆ ◆

. . . Thatcher's Green to GCMI's board

Wm. J. Green, executive vice president of Thatcher Glass Mfg. Co., Inc., Elmira, N. Y., has been elected to the board of trustees of Glass Container Manufacturers Institute, Inc., 99 Park Ave., New York 16, N. Y. Green fills the unexpired term of **Franklin B. Pollock,** Thatcher Board chairman and president, who resigned from the GCMI board after five years of service.

◆ ◆ ◆

Albert E. Ponter, Jr., has been appointed manager, Foreign Department, Crown Cork and Seal Co., Inc. Until recently manager of export sales of Rayonier, Inc., he will be responsible for coordinating the work of the company's export sales operations in overseas markets.

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Members of the Food Manufacturers' Federation, Food Machinery Association, recently visited the Dehydration Exhibition at the Ministry of Agriculture, Fisheries and Food, Great Westminster House, Horseferry Rd., London, S.W. 1. In the photo, G. N. Lawrence, left, Liaison Officer for Food Development and Dehydration, Ministry of Agriculture, Fisheries and Food, shows R. G. Tomkins, center, Superintendent of the Ditton Laboratory, D.S.I.R., and Dr. R. J. L. Allen of Beecham Foods Ltd., a large colored photograph of a meal of dehydrated foods ready to serve, which formed the centerpiece of the Exhibition.

Fred K. Crosby has been named president of Ocoma Foods Co., subsidiary of Consolidated Foods Corp., Chicago. Crosby, with Ocoma since 1931, succeeds Homer C. Sheridan, who has retired but will continue to serve as a director and consultant. Ocoma also announces that **Wm. E. Carey,** formerly director of sales, has been appointed executive vice president in charge of sales and advertising.

◆ ◆ ◆

. . . Staley's Bentley . . . Eastward Ho!

Expansion of the Refined Oil Sales Department of A. E. Staley Mfg. Co., Decatur, Ill., corn and soybean processors, has resulted in promotion of three employees. **Russell Bentley,** district manager in charge of oil sales in San Francisco, will now be in charge of refined oil sales in the entire New York metropolitan area. Replacing Bentley in San Francisco is **Robert D. Stain,** promoted from a position in the oil sales office in Decatur. **Sam D. Roller,** senior clerk in Staley's crude oil sales department, takes over Stain's former position.

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